INTERNATIONAL SEISMOLOGICAL CENTRE (ISC)

2021

Annual Director's Report

This was the first year the ISC operated as a charitable incorporated organization (CIO). Despite the continuation of the pandemic, it was a rather productive year thanks to the support of 71 Member-Institutions and 11 Project Sponsors.

As the result of a special effort, production of the Reviewed Bulletin was finally brought back to 24 months behind real time. The data for seismic events during 2018-2021 have been added to the ISC Bulletin. The ISC continued using openly available waveforms to determine the probabilistic point source models, the source mechanisms based on first motion polarities, and to constrain earthquake depths, based on depth phase pickings. Smaller continental earthquakes during the 1976-2017 period and source mechanisms from literature (1915-1989) have been added to the ISC-GEM catalogue. The ISC-EHB dataset and corresponding subduction zone cross-sections have been extended to include the data year 2018.

A new ISC service – the Electronic Archive of Printed Station/Network Bulletins has been put into operation. Both the ISC product download statistics and the large number of scientific research articles indicate extensive worldwide use of ISC data.

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1: EXECUTIVE SUMMARY

- The ISC gratefully acknowledges generous support from **71 Member-Institutions in 47 countries** and additional project grants (**23%** of total income) from CTBTO, USGS, BGR, FM Global, Lighthill Risk Network, MS&AD InterRisk as well as sponsorships from REF TEK, GeoSIG, TAIDE, SRC and Guralp.
- This was the first year the ISC operated as a charitable incorporated organization (CIO); this status allows the ISC to be run in the most tax-efficient manner.
- The 2021 annual income exceeded the ISC's expenditure by £48,988; this surplus will help to compensate losses expected in the coming years.
- We are grateful to all Members paying their fees promptly and in full; £15,820 was still owed to the ISC on the 31st of December 2021; all fees, except those written off as bad debt (NCS, India), have been repaid at the time of writing this report.
- At any one time, 16-17 staff members and 2 contractors worked at the ISC this year.
- 602 seismic stations were registered or modified in the **International Seismograph Station Registry**.
- Within a few days after an event occurrence, the ISC collected and grouped preliminary data from 26 networks and made the **Preliminary ISC Bulletin** available to all users.
- The routine process of collecting revised bulletins from **150** institutions in **91** countries stood at 12 months behind real time; many agencies were not able to comply with this deadline and inadvertently hindered the ISC Bulletin analysis.
- During the year, the analysts fully reviewed 15 months of the **ISC Bulletin** and partially reviewed a further 2 months, finally bringing the ISC Bulletin availability forward to our target: 24 months behind real time (b.r.t.).
- Overall, ~86,000 reviewed events with ~10.6 million associated phases were added to the reviewed part of the Bulletin. The Bulletin (both reviewed and un-reviewed) was enlarged with ~815,000 events and ~25.4 million associated phases.
- 1,611 ISC focal mechanisms for recent events (July 2018 – December 2019) were added to the Bulletin based on both the reported first motion polarities and those automatically picked by the ISC using waveforms available on-line.
- 201 PPSM (probabilistic point source model) solutions for earthquakes during the period January-December 2019 were added to the ISC Bulletin based on our analysis of waveforms.
- We continued waveform picking of depth phases (global) and general seismic phases (Africa) to fill the gaps in agency reporting. It helped to constrain the depth of 1,064 events where there was no sufficient information otherwise.
- The ISC Bulletin remains more complete than the bulletins of either NEIC or IDC.
- We worked on three further issues of the printed **Summary of the ISC Bulletin,** which included several invited articles; each issue and each invited article now has its own DOI registered via the ISC's membership of CrossRef.
- The **ISC-GEM Global Instrumental Earthquake Catalogue** has been advanced to include ~6,900 small continental shallow earthquakes during 1976-2017 and 91

earthquake mechanisms (1915-1989) from scientific literature; it was further extended to include the year 2018.

- References to ~2,199 scientific articles related to ~3,450 seismic events have been added to the **ISC Event Bibliography.**
- A new ISC service – the **Electronic Archive of Printed Station/Network Bulletins** has been put into operation.
- We continued the operation and improvement of the **CTBTO Link to the ISC database** which experienced a steady stream of data requests from NDC and IDC personnel.
- The ISC database and the website mirrors at IRIS DMC in Seattle, ERI in Tokyo, LLNL in Livermore and CEA in Beijing/Xian helped to maintain a reasonable speed of access to ISC data. These mirrors (especially at IRIS DMC) helped to deal with data distribution during the ISC database server crash in April 2021.
- 152 GT events have been added to the IASPEI Reference (**GT**) Event List.
- We extended the **ISC-EHB** dataset to include 7,880 events for the data year 2018.
- We continued to run the **Seismological Dataset Repository** and the **International Contacts in Seismology**.
- We participated in a number of international scientific conferences, mostly on-line.
- The ISC contributed to the work of **IASPEI** by maintaining the IASPEI website, leading several working groups and working at the IASPEI ExecCom.
- Impressive ISC data download statistics and a large number of published scientific articles using ISC data indicate very wide and extensive use of ISC products by researchers worldwide.

Signed, 10th June 2022
Dr. Dmitry A. Storchak
Director

2: STAFF and CONTRACTORS

A total of 18 members of staff (16-17 at any one time) and two contractors worked at the ISC throughout the year, thanks to the regular Member's support and a number of additional grants given to the ISC by international organizations, public institutions and commercial companies to work on the ISC-GEM catalogue, CTBTO Link and Station Registry. Staff changes through the year are highlighted in red or light blue.

Among the staff, there were 7 Ph.D., 4 M.Sc. or equivalent, and 4 B.Sc. or equivalent degrees. The ISC staff represents 9 different countries from 3 continents. Several members of staff took part in professional meetings, international conferences and professional training programmes, predominantly on-line.

ISC staff often organise sessions at scientific conferences. Several ISC staff are members of professional organizations such as IASPEI, EGU, AGU and SSA. ISC staff members are engaged in IASPEI's Executive Committee, commissions and working groups.

MANAGEMENT and ADMINISTRATION

Dmitry Storchak, Ph.D.
Director/Seismologist
Russia/UK

Lynn Elms
Administration Officer
UK

SYSTEM ADMINISTRATION, SOFTWARE and WEB DEVELOPMENT

James Harris
Senior Systems & Database Administrator,
UK

Oliver Rea, B.Sc.
Systems Administrator,
UK

Adrian Armstrong,
B.Comp.Sc.,
Software Engineer, *UK*,
joined in September

BULLETIN DATA COLLECTION and ENTRY

The Data Collection Officer communicates with agencies and manages routine automatic entry of reported data. The Historical and Bibliographical Data Entry Officer helps with entering paper-based data into the ISC database and maintaining the ISC Event Bibliography.

Gary Job,
Data Collection Officer, *UK*

Daniela Olaru,
M.Sc.Admin., Historical and Biblio Data Entry Officer, *Romania/UK*, left in December

BULLETIN ANALYSIS TEAM

Up to 7 analysts (two part-time) and one contractor reviewed the ISC Bulletin and performed limited waveform analysis. Each analyst has an additional task either in development or data collection.

Kathrin Lieser, Ph.D.
Seismologist / Analyst Administrator / Editor of the Summary, *Germany*

Elizabeth Ayres, B.Sc. Geog., Analyst/Historical Data Officer, *UK*

Blessing Shumba, M.Sc.
Seismologist / Senior Analyst, *Zimbabwe/UK*

Burak Sakarya, M.Sc.,
Seismologist/Analyst,
Turkey

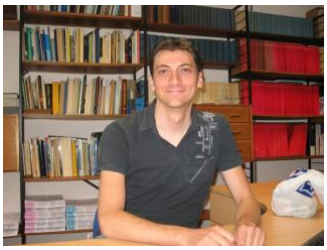
Rebecca Verney, B.Sc.,
Analyst/Historical Data Officer, 3 days a week, *UK*

Rosemary Hulin,
M.Phys. Geog., 3 days a week, *UK*

Peter Franek, Ph.D.,
Seismologist/Analyst,

Slovakia, left in May

DEVELOPMENT PROJECTS



Domenico Di Giacomo
Ph.D.
Senior Seismologist
Italy/UK

Thomas Garth, PhD
Seismologist/ Senior
Developer, UK

Ryan Gallacher, PhD,
Seismologist/Developer,
UK,
joined in January

Natalia Poiata, PhD,
Seismologist/Developer,
Moldova/Romania,
joined in April

CONTRACTORS

During the year, the following persons also contributed as contractors:

- **E.R. Engdahl**, Ph.D., *Boulder*, *USA*: overseeing preparation of the ISC-EHB dataset;
- **Lonn Brown**, M.Sc., University of Alberta, *Edmonton, Canada:* former ISC Analyst, taking part in analysis of the ISC Bulletin remotely

3: DEVELOPMENT of GOVERNANCE DOCUMENTS

The ISC is now governed by its Constitution and Bye-laws. The Constitution is a legal instrument that was adopted at the point of registration with the Charity Commission and endorsed by the Extraordinary Meeting of the ISC Governing Council on May 12, 2020. The Bye-laws, fully compliant with the Constitution, provide further details and clarification of exact rules and procedures applicable in the day-to-day operation of the ISC in pursuit of its mission. The Bye-laws were prepared during 2020-2021 and adopted by the on-line Biennial General Meeting (BSM) of the Governing Council on June 21, 2021. A combination of the Constitution and Bye-laws completely replace the old Working Statutes that were in use since the early 1970s.

The Bye-laws specify the ISC mission and principle tasks, describe the ISC Data Reporters, Members, Sponsors, and the Host Institution. The Bye-laws specify the way the Governing Council and the Executive Committee (Board of Trustees) conduct their business meetings and elect new members. The Bye-laws also specify the Director's responsibilities and financial provisions of ISC operations. Some of these topics have become an accepted norm over the years but have never been spelled out in a single document. This document will also help new seismologists coming to work at the ISC and its governing bodies in the future.

4: OPERATIONS

STATION REGISTRY AS PART OF ADSL DATABASE

The International Seismograph Station Registry (IR) allocates globally unique codes to seismic stations worldwide. During 2021, the IR has been particularly improved and extended in Europe, the Mediterranean, Caucasus, Central Asia, Central and South America and the Caribbean region (Fig. 1) as part of the regular ISC Bulletin work.

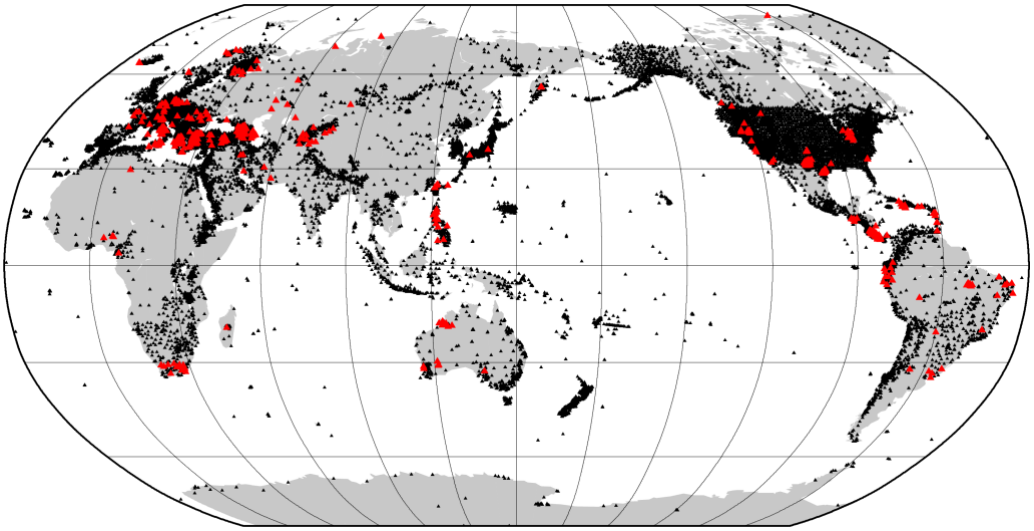


Figure 1. *29,410 stations, open or closed, were fully registered in the International Seismographic Station Registry at the end of 2021; parameters of 602 of those (in red) were either registered or modified during this year.*

The ISC runs a popular web page giving an account of already registered stations as well as inviting the submission of parameters required to register a new station.

In fact, the IR has become part of the ADSL database (Agency.Deployment.Station.Location) which we designed and continue maintaining jointly with NEIC. The ISC maintains the agency.deployment "ISC.IR" as a subset of ADSL. In order to use all waveform data available on-line, NEIC routinely updates the ADSL database with stations under the deployment codes equal to corresponding FDSN two-character network codes, based on dataless mini-SEED files available at IRIS DMC. NEIC no longer needs the IR in day-to-day operations since they use waveforms of stations available on-line, usually with FDSN codes.

Now and in the future, the globally unique ISC.IR station codes will remain an exclusive source of station position information for the historical period of time. Also, the ISC.IR will continue to cover a large number of stations whose waveform data are not available to the international waveform data centres.

At present, for the majority of its standard operational activities, the ISC uses just the IR (almost equivalent to ISC.IR element of the ADSL database). In order to be able to deal with a multitude of additional stations becoming available largerly from NEIC, the ISC plans to switch to working with the entire ADSL. To make this happen, a very large effort is required to update, test and validate almost the entire operational and web distribution computer code at the ISC. This work was begun in 2019 but progressed slowly due to a major conflict with the Bulletin Rebuild project that required us to run two main ISC databases at the same time.

During 2021, we :

- changed the ISC Bulletin web-search to use the ISF2.1 format (which implements ADSL station coding) as the default;
- studied the code of the ISC location program to see how to use it with the ADSL; it was found to be ADSL-compliant as far the hypocentre location process and calculation of uncertainties are concerned; potential difficulties related to ISC magnitude computation have been identified; we are therefore building plans to safeguard the ISC magnitude values from being skewed by data of the same station reported with different network codes or stations positioned very closely to each other;
- planned measures to enable the use of ISC-EHB software with ADSL; in particular, we worked on the FFB-output format used in ISC-EHB production and distribution;
- made extensive checks to bring FDSN station coordinates into ADSL;
- started adjusting individual agency bulletin parsers to work with ADSL.

Overall, the work on ADSL did not go as fast as we wanted due to a number of other urgent needs. We shall thus continue with this project throughout 2022.

ISC BULLETIN

Collecting Preliminary Network Bulletins

The ISC continues to collect preliminary bulletin data from a large number of networks and data centres. These data are expected to have undergone at least a minimal review by local analysts. Typically, the incoming data include a preliminary hypocentre location, magnitude estimates, moment tensor solution and station arrival data, though there are large variations from agency to agency. 26 agencies reported preliminary data during year 2021 (Table 1).

***Table 1**. Agencies that reported preliminary hypocentre determinations and corresponding arrival time data to the ISC in 2021.*

Country	Reporting Agency
Armenia	National Survey of Seismic Protection
Australia	Geoscience Australia
Austria	Zentralanstalt fur Meteorologie und Geodynamik (ZAMG)
Canada	Canadian Hazards Information Service, Natural Resources Canada
Cyprus	Cyprus Geological Survey Department
Czech Republic	Geophysical Institute, Academy of Sciences of the Czech Republic
Denmark	Geological Survey of Denmark and Greenland
Finland	Institute of Seismology, University of Helsinki
France	Centre Sismologique Euro-Mediterranean (CSEM/EMSC)
Germany	Helmholtz Centre Potsdam, GFZ Research Centre for Geosciences
Germany	Landeserdbebendienst Baden-Wurttemberg
Hungary	Geodetic and Geophysical Research Institute
India	National Geophysical Research Institute
Italy	Istituto Nazionale di Geofisica e Vulcanologia
Japan	Japan Meteorological Agency
Kyrgyzstan	Institute of Seismology, Academy of Sciences of Kyrgyz Republic
Norway	University of Bergen
Norway	Stiftelsen NORSAR
Romania	National Institute for Earth Physics
Russia	Geophysical Survey of Russian Academy of Sciences (GS RAS)
Russia	Baykal Regional Seismological Centre, GS RAS
Russia	Kamchatka Branch, GS RAS
Slovenia	Slovenian Environment Agency
Spain	Instituto Geografico Nacional
UK	British Geological Survey
USA	NEIC, USGS

There are 21 agencies that produce bulletins soon after an event occurrence and never return to event re-analysis unless there is a special need (Table 2). These agencies can be considered as reporting both preliminary and final bulletins at the same time.

Table 2. Agencies that reported final analysis results within a month of event occurrence

Country	Reporting Agency
Australia	Geoscience Australia
Austria	International Data Centre, CTBTO
Chinese Taipei	Institute of Earth Sciences, Academia Sinica
France	Institut de Physique du Globe de Paris
France	Laboratoire de Detection et de Geophysique/CEA
French Polynesia	Laboratoire de Geophysique/CEA
Germany	Alfred Wegener Institute for Polar and Marine Research
Germany	GFZ Potsdam

Greece	National Observatory of Athens
Greece	University of Patras, Department of Geology
Ireland	Dublin Institute for Advanced Studies
Namibia	Geological Survey of Namibia
New Zealand	Institute of Geological and Nuclear Sciences
Norway	Stiftelsen NORSAR
Poland	Institute of Geophysics, Polish Academy of Sciences
Portugal	Instituto Geofisico do Infante Dom Luiz
Portugal	Sistema de Vigilância Sismológica dos Açores
Romania	National Institute for Earth Physics
Spain	Real Instituto y Observatorio de la Armada
Switzerland	Swiss Seismological Service
USA	Pacific Tsunami Warning Center

Notably, the availability of data from the IDC/CTBTO bulletin (REB) stayed as agreed with CTBTO – seven days after formal release of each REB data day. This is essential since the ISC is the only channel through which academic research scientists can get regular uninterrupted access to the REB event and station recording parameters (not original bulletins) except for the most recent 10-14 days. In line with CTBTO's formal conditions of release, the ISC is not allowed to make the original REB bulletins openly available.

Building the Preliminary ISC Bulletin

Preliminary hypocentre solutions and station arrivals are grouped in the ISC database with corresponding solutions from other agencies and made available through the standard ISC Bulletin search procedure within a few hours of receipt. For each event an output includes several hypocentre solutions reported by various agencies, all reported source mechanisms and magnitude estimates as well as corresponding station arrival data. Event headers include logo images of each reporting agency and, by clicking on the logo, Preliminary ISC Bulletin users can get further information from each agency directly.

Almost all events with magnitude 5 and above and many of smaller magnitude are reported within the first week. Further reports beyond one week add information to already reported large and moderate events and also inform about smaller events.

This process is there to fill the gap between the event occurrence and the time when the final Reviewed ISC Bulletin becomes available. It presents an attempt to consolidate the effort of many data centres and networks to make their data available internationally in good time. At this stage the ISC does not compute or publish its own event solutions. This service is not intended for use by the media or civil protection agencies. It is designed to be used by seismologists to receive as much information as possible in one single format from one single source and then to get access to details using the links provided to the original data reporters.

Approximately one year after each seismic event occurrence, the preliminary data from agencies are substituted with their final, revised versions; this is well before the ISC analysts make their final review of the ISC Bulletin. The ISC hypocentre solutions are still based only on the revised set of bulletin parametric data given by each reporting institution.

Collecting Revised Network Bulletins

The standard ISC data collection pulls together revised bulletins from agencies (network data centres and single observatories) around the world up to 12 months behind real time. This delay gives the majority of data contributors enough time for reviewing and finalising their bulletin data before submission to the ISC. There is though still a considerable number of agencies that delay their reports to up to 24 months behind real time, giving the ISC little time to apprehend the data before the analysis begins. The global pandemic has obviously made the ISC data collection harder as many agency's staff, based at home, were unable to analyse and send their data to the ISC on time.

Appendix 1 lists 150 agencies in 91 countries that contributed revised seismic bulletins to the ISC during the calendar year 2021. It is important to note that among them there is one regional data concentrator - the NEIC/USGS, which in fact represents a number of US-based networks.

Notably, one of the data contributors is the ISC itself, with depth phase arrival time picks for earthquakes worldwide, arrival time picks from African stations for earthquakes in Africa as well as PPSM solutions and source mechanisms based on polarities of first motions.

Figure 2 shows countries and agencies that contributed revised bulletins for various months and years, directly or indirectly (via other agencies), during 2021. Figure 3 shows those agencies that reported data for the data months that the ISC reviewed during 2021. This collection is generally more complete (see the improvement in Cameroon, South Africa, Thailand, etc) due to the efforts of the Data Collection Officer and the Director to obtain missing agency data before the analysis at the ISC began.

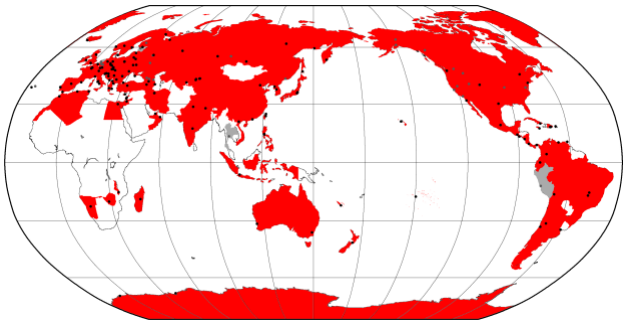


***Figure 2**. Agencies (black dots) and corresponding countries (in colour) that reported revised bulletins during 2021; red/grey colours indicate direct/indirect contributions.*

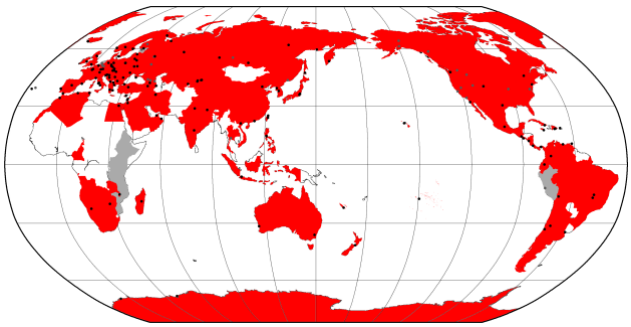


***Figure 3**. Agencies and corresponding countries that reported revised bulletins for the data months reviewed by the ISC in 2021: Sep 2018 – Jan 2020.*

During 2021, we experienced highly irregular data deliveries in several countries caused by the consequences of the global pandemic and a large backlog of data to be processed.

Among the new data received during 2021, we should mention the seismic bulletins from:

- Institute of Geology, Komi Science Centre, Ural Branch, Russian Academy of Sciences

The ISC Bulletin is progressively updated with each network report coming in. Preliminary network contributions are substituted with final reviews. New events are built, merged or split with every new report coming to the ISC by e-mail and processed either automatically or manually by the ISC Data Collection Officer.

The Analyst Administrator and the Data Collection Officer regularly review the status of data collection and contact various agencies to avoid reporting gaps. The Director helps to address urgent and difficult cases.

First Motion Based Focal Mechanisms (ISC-FM) Computed in House

In 2021, we continued with the production of focal mechanisms, calculated in house at the ISC and based on first motion polarities. Focal mechanisms of recent earthquakes are calculated automatically, combining first motion polarities reported to the ISC with auto-picked first motions from waveforms available at IRIS, EIDA, and other openly accessible waveform archives. We look at all earthquakes in the reviewed ISC bulletin with a magnitude $mb_{ISC} \geq 4.5$ and focus especially on earthquakes with no previously reported source mechanisms (Fig. 4). In this work we use the HASH algorithm to compute focal mechanisms (Hardebeck and Shearer, 2002) and FilterPicker source code to automatically determine the polarities of first motions (Lomax *et al.*, 2012). The entire procedure is described in scientific papers published by Lentas (2018) and Lentas and Harris (2019).

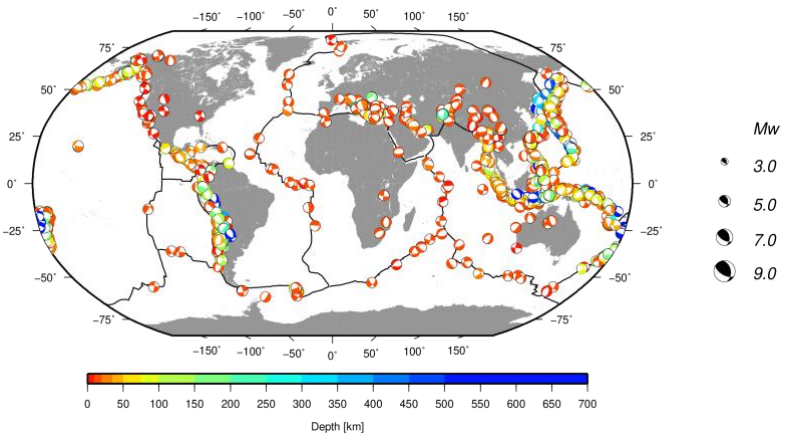


Figure 4*. Map of 1,611 earthquakes from July 2018 to December 2019 for which the source mechanisms were computed by the ISC during 2021 and made available through the on-line bulletin.*

In House Waveform Picking of Depth Phases

Since 1964, the ISC's mission has been based on re-using the seismogram (waveform) arrival time measurements (picks) made by many tens of observatories and data centres. In recent years, the ISC used reported arrival times of ~10.5 thousand stations worldwide. The ISC does not have sufficient staff capacity to obtain those picks from waveforms, even if these waveforms were always available. We nevertheless feel that the value and quality of the ISC Bulletin would have been compromised if we didn't act in two particular areas.

Depth phases such as pP, sP, pPKP, sPKP etc. are crucial for constraining the hypocentre depth of many moderate earthquakes in the ISC Bulletin that occur too far away from monitoring stations. During the last 10-14 years though, we have observed a steady decline in the number of depth phases reported by agencies.

Since 2018, we set aside a small fraction of analyst resources to deal with the problem. Several ISC analysts have been picking the depth phases on waveforms available from IRIS DMC for earthquakes with $mb^{NEIC} \geq 4.8$, using the SEISAN software (Havskov *et al*., 1999, 2010, 2020). The results of this activity were used in the routine production of the ISC Bulletin.

Depth phases for 1,610 earthquakes were added to the ISC Bulletin during this year. Figure 5 shows 1,064 events for which this information was crucial, i.e., the depth would have otherwise had to be fixed to the area's default. Figure 6 shows the worldwide distribution of 163 stations used and their comparative input. As expected, stations in quiet regions of Asia, Australia, Antarctica and North America provided the largest input.

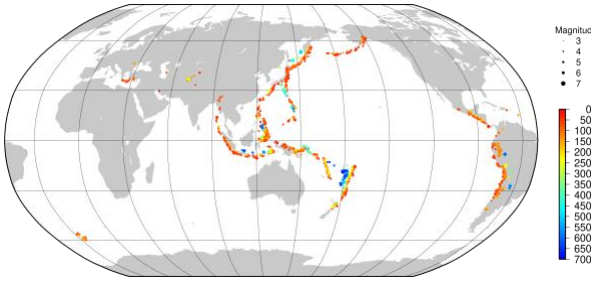


***Fig. 5**. The map of 1,064 events where additional ISC pP/sP picks were critical to constrain the ISC event depths.*

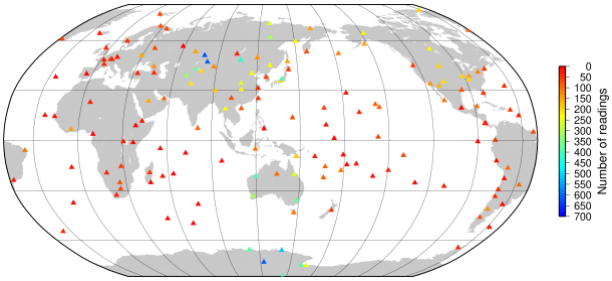


***Fig. 6**. Waveforms of 163 stations were used by the ISC to deliver the missing pP/sP picks; relative contributions are shown by colour.*

We also continued picking waveforms from the Africa Array to compensate for the unfortunate lack of permanent observations over large parts of this continent. We include these picks in the routine production of the ISC Bulletin.

Bulletin Review (finally reaching 24 months b.r.t.)

When the time comes, one month's worth of data is pulled into a separate database and a set of automatic procedures are run to produce automatic ISC event locations and magnitude determinations for those events that are large enough to be reviewed by the ISC analysts. The threshold criteria are complex yet almost all events of magnitude 3.5 and larger are reviewed.

The ISC seismologists/analysts currently review ~10% of all events formed in the ISC database by the automatic procedures. Although this review misses smaller events, it makes the most used part of the ISC Bulletin accurate and trustworthy. The accuracy of *ak135*-based (Kennett *et al.*, 1995) ISC solutions and magnitude estimates, and proper grouping of reported information between the events in the Bulletin is under constant scrutiny. The ISC analysts also review the correctness of automatic association of reported station arrivals to events, reported arrival's phase identification and travel-time residuals.

All analysis work is done using the Visual Bulletin Analysis System (VBAS) that throughout the year allowed the analysts to work both in the office and at their private homes.

Throughout 2021, the Analyst Team varied between 6.2 at the start of the year and 5.2 members in the second half of the year. The Team was also assisted by an outside contractor (former member of the Team) as well as some members of the Team working additional hours during weekends.

During 2021, the Team conducted the review of the standard current ISC Bulletin, successfully recovering the delay in analysis accumulated over recent years when the VBAS was built and the Rebuild project was accomplished (Fig.7). In addition, members of the Team were involved in other projects such as the ISC-EHB bulletin, Event Bibliography, ISC-GEM catalogue, depth phase picking from waveforms and production of the printed/electronic Summary of the ISC Bulletin.

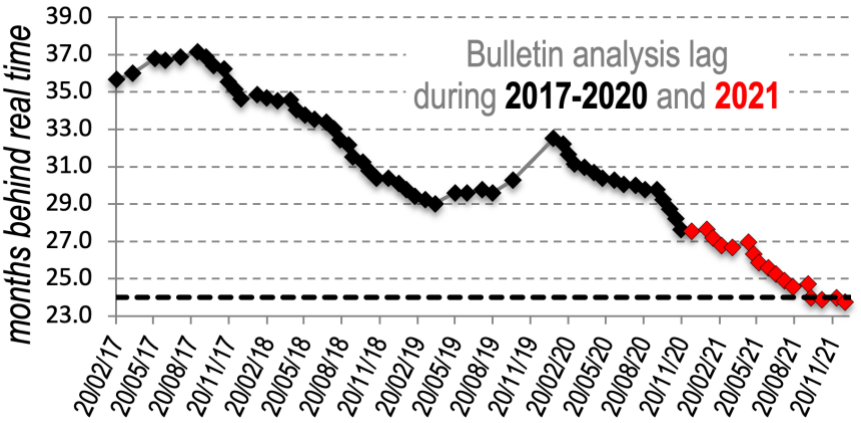


***Figure 7**. Further lag reduction in availability of the Reviewed ISC Bulletin during 2021; **the 24 months behind real time (b.r.t.) target has finally been reached**.*

As a result, during 2021, the Analysis Team fully reviewed **15** complete data months of the recent ISC Bulletin with **2** data months receiving partial review. The analysis covered data from September 2018 to January 2020. The analysts were working with approximately the same monthly number of events as during the previous five years (Fig. 8). Nevertheless, the number of associated phases reviewed by analysts remained on the increase as new stations and networks were installed. By design, VBAS helped to alleviate this problem.

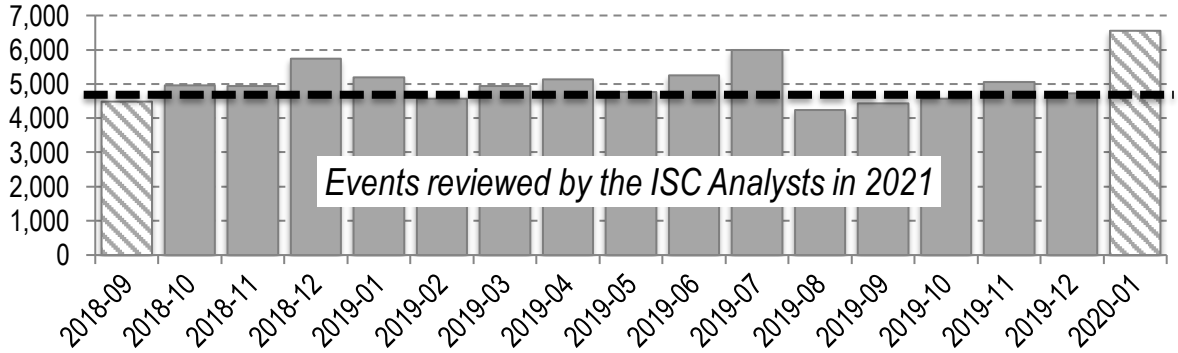


***Figure 8**. Monthly number of seismic events in the Reviewed ISC Bulletin analysed during 2021; the solid colour represents those data months that were fully completed during the year; the dashed line shows the average monthly number during the preceding 5 years.*

During the calendar year 2021 *(2020)*, ~86,000 *(~87,000)* reviewed events with ~10.6 *(~11.6)* million associated phases were added to the reviewed part of the Bulletin by the ISC analysts. Overall, the Bulletin (both reviewed and un-reviewed) was enlarged with ~815,000 (~949,000) events and ~25.4 (~29.9) million associated phases. During the calendar year 2021, once the analysts reached the 24 months b.r.t. mark, the production of the Bulletin went steady, with one data month released in each calendar month. Hence, fewer events and associated phases have been reviewed during 2021 as compared to 2020.

The result of the ISC work can be seen when comparing Figures 9 and 10. A fuzzy picture of the originally reported seismicity is sharpened in the Reviewed ISC Bulletin.

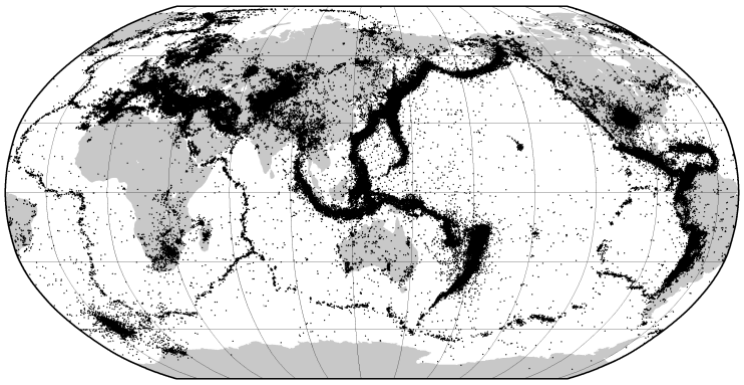


***Figure 9**. All hypocentres reported by individual networks (September 2018 – January 2020).*

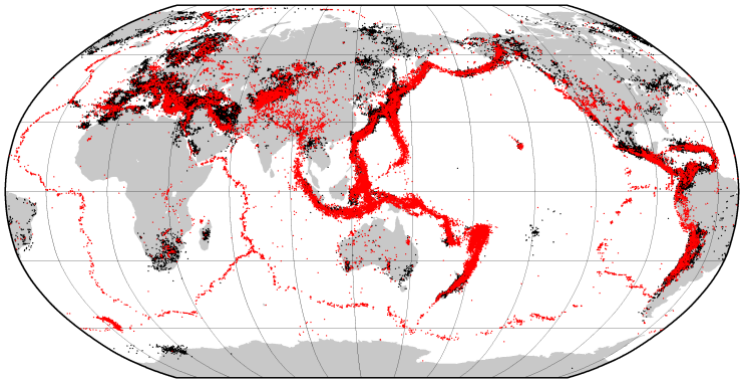


***Figure 10**. Primary hypocentres in the ISC Bulletin (black) in the period (September 2018 – January 2020); in red are the reviewed events.*

Figure 11 demonstrates the diversity of seismic phases included in the ISC Bulletin.

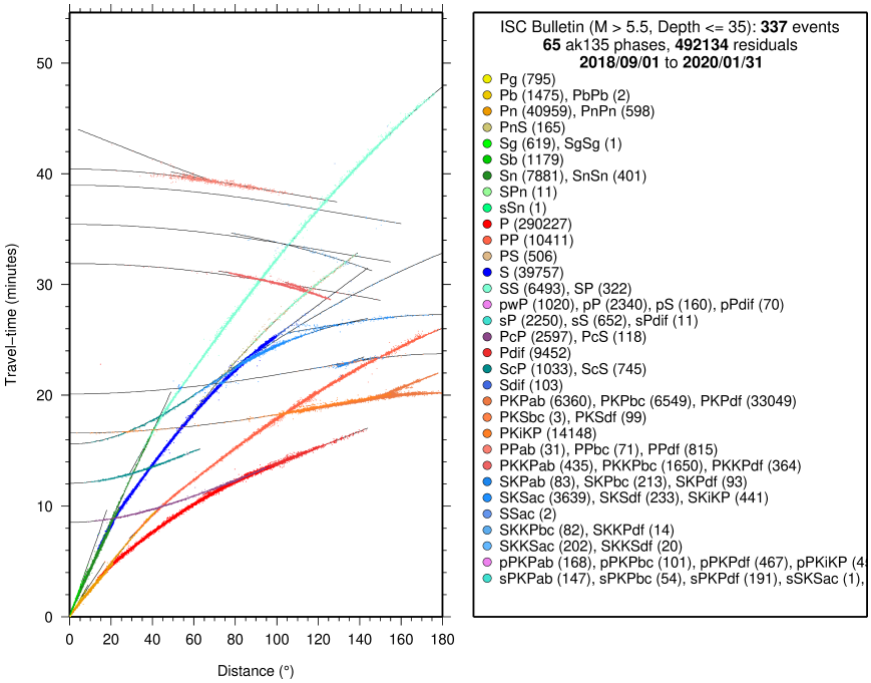


Figure 11. The travel-time graph and associated table show the statistics of various seismic phases (Storchak *et al.*, 2003, 2011; Schweitzer *et al.*, 2019) generated by large shallow events reviewed by the ISC analysts during 2021; depth <=35 km and magnitude above 5.5 are shown.

General Statistics of the ISC Bulletin

The ISC Bulletin and the ISC database grow by the day in both seismic event (earthquake or explosion) numbers (Fig. 12) and reported seismic wave arrival times and amplitudes of seismic waves recorded at stations registered in the IR (Fig. 13). Please note that the numbers on these graphs were taken after the ISC Bulletin was fully rebuilt for the period 1964 to 2010.

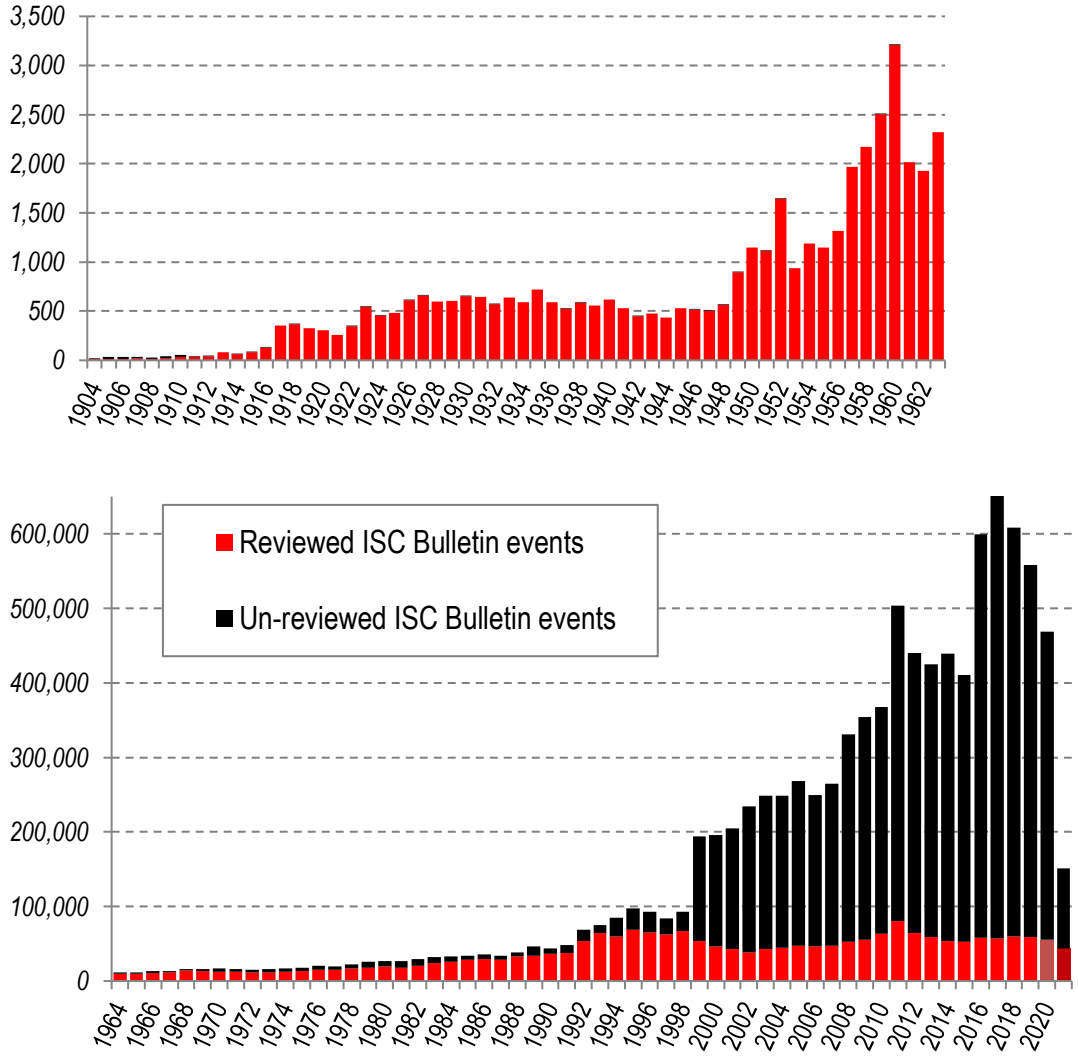


***Figure 12**. Timeline of the annual number of reviewed and un-reviewed (small) events in the ISC Bulletin; the total height of each column represents the annual number of all seismic events in the ISC Bulletin; note different scale used for events before and after 1964; "Reviewed" events beyond January 2020 (dark red) are those intended for review.*

Numbers as of Apr 4, 2022

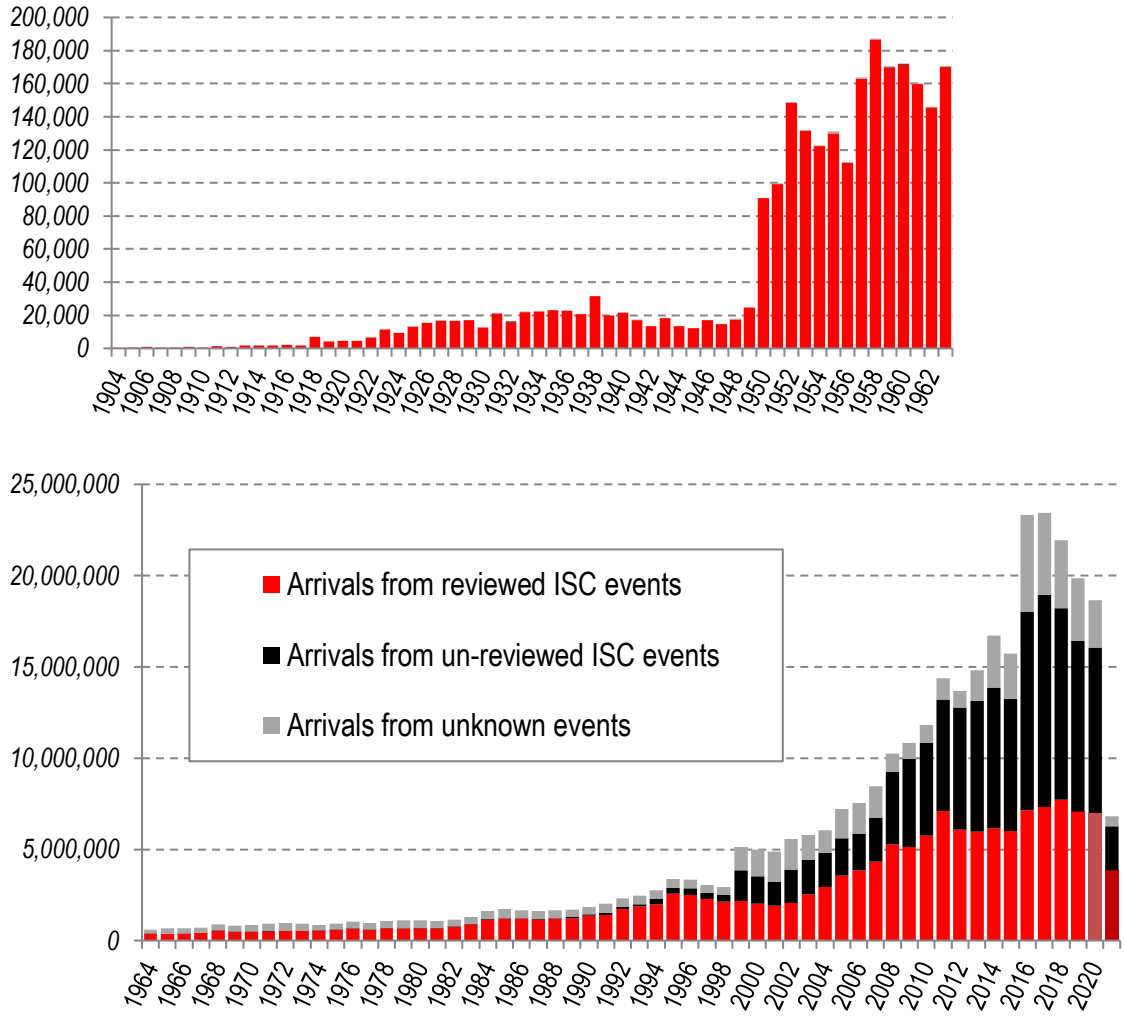


***Figure 13**. Timeline of the annual number of seismic arrivals associated with both reviewed (red) and un-reviewed (black) events in the ISC Bulletin, as well as those arrivals in the ISC database that are not associated to any known event (grey); the total height of each column represents the annual number of all seismic arrivals in the ISC database; note different scales used for events before and after 1964; "reviewed" events beyond January 2020 (dark red) are those intended for review.* Numbers as of April 4, 2022

Figure 14 demonstrates the comparative magnitude completeness of the ISC Bulletin and bulletins of NEIC/USGS and IDC/CTBTO. The ISC Bulletin appears to be more complete globally than NEIC or IDC by at least half a unit of magnitude. The NEIC's current global operational magnitude cut-off threshold is 4.5. Smaller events are routinely included only for US territories. Thus, the ISC Bulletin is more complete by definition. The IDC is unlikely to use many more seismic sites/arrays than they use at present because the exact IMS network station positions are a fixed part of the Comprehensive Test Ban Treaty. Hence, the Bulletin of the ISC is likely to stay more complete than that of either NEIC or IDC.

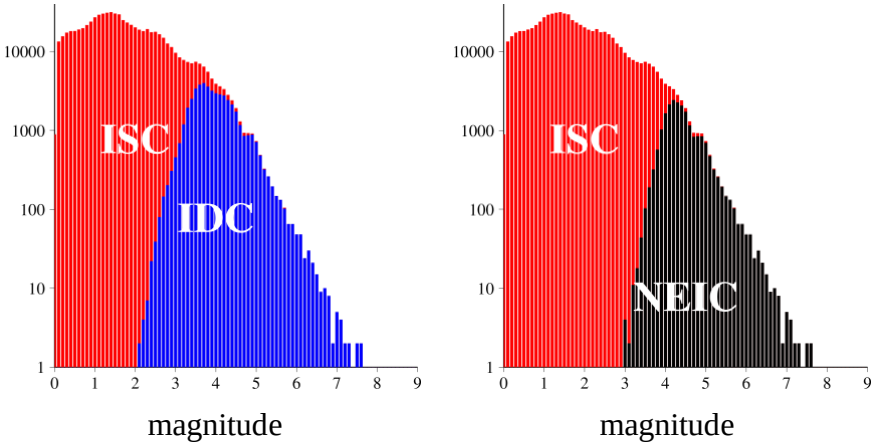


***Figure 14**. Number of seismic events of different magnitude in the ISC, IDC/CTBTO (left) and NEIC/USGS (right) bulletins during the period from September 2018 to January 2020.*

The ISC Bulletin is used by a large number of researchers worldwide. The number of bulletin web searches in 2021 was similar to that in the previous year (Figures 15 and 16). Notably, ~34% of Bulletin searches are done through the fdsn-webservice and ~66% - through the ISC website. The above number doesn't even include searches through the ISC mirror at ERI, CTBTO, LLNL or CEA. Nor does it include individual user searches based on flat bulletin files downloaded by some users from the ftp-site.

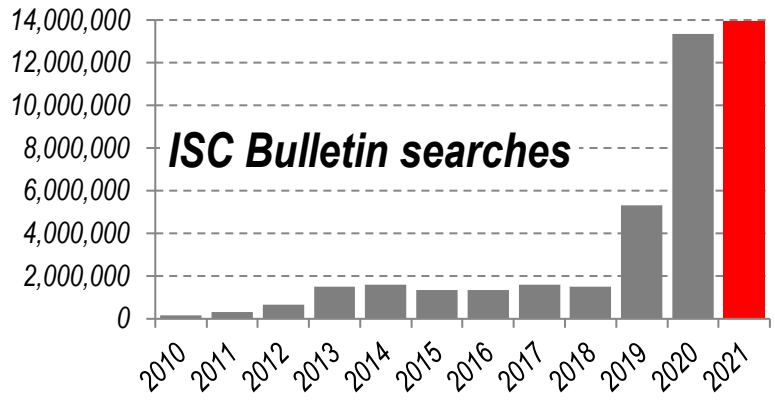


***Figure 15**. The annual number of ISC Bulletin searches made by users; during 2021, the search numbers averaged **27 per minute**.*

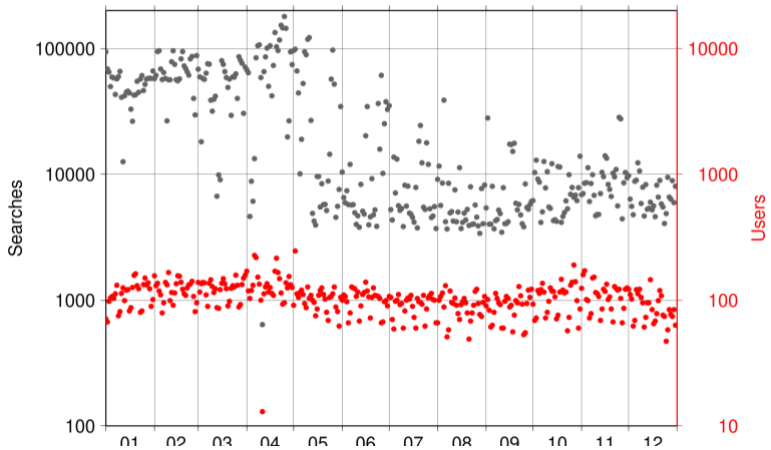


***Figure 16**. Daily distribution of Bulletin searches and individual users during 2021*

Figure 17 shows the multinational character of the ISC Bulletin search users.

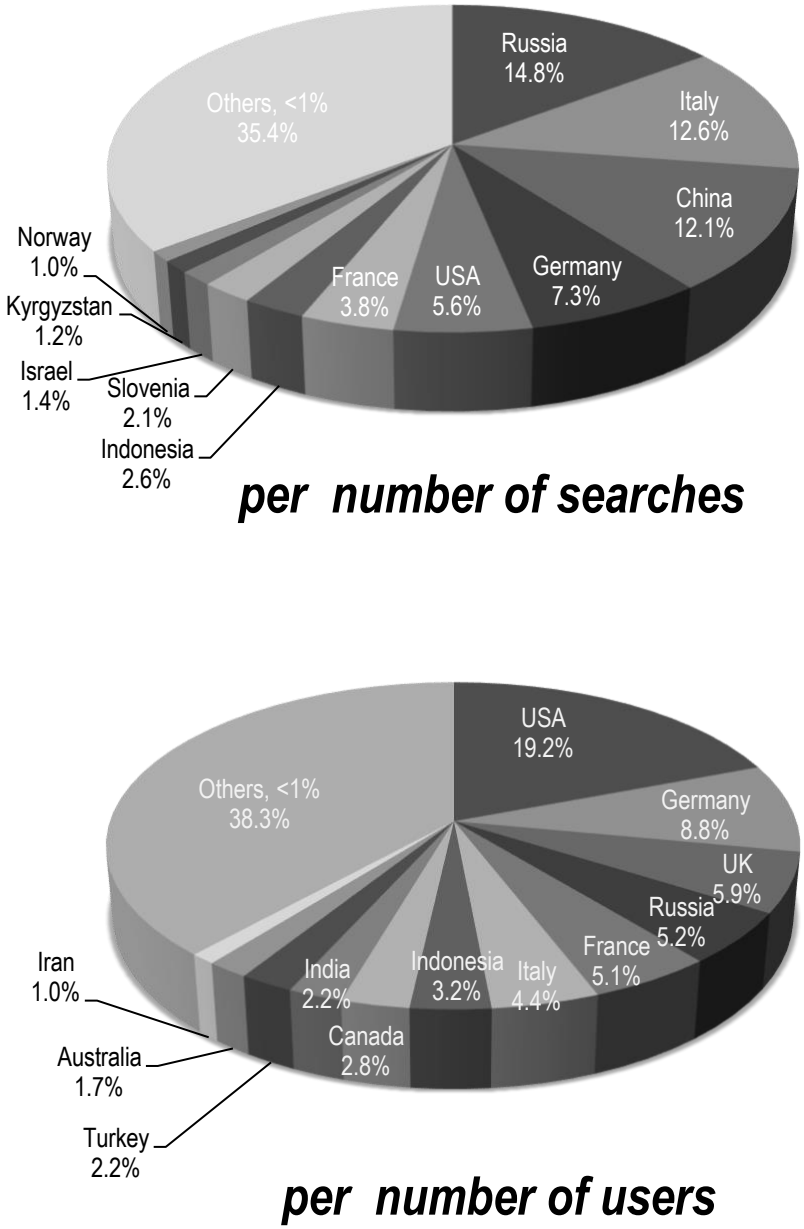


Figure 17*. International usage of the ISC Bulletin in 2021: per number of searches (top) and per number of individual users (bottom).*

The above statistics include the use of the ISC mirror website at IRIS DMC, but not bulletin searches made from mirror-sites at ERI in Tokyo and LLNL in Livermore. Where reliably known, we have removed the numbers related to web crawlers.

Currently, the website searches give output in three major formats: ISF2.1 (International Seismic Format), QML (QuakeML) and CSV (comma separated variables). Figure 18 shows that the total number of searches in QML exceeds those of ISF or CSV. The QuakeML searches though, are performed by fewer users who tend to run automated queries that request larger volumes of data. It therefore appears that all three formats are popular and need to be maintained in the future.

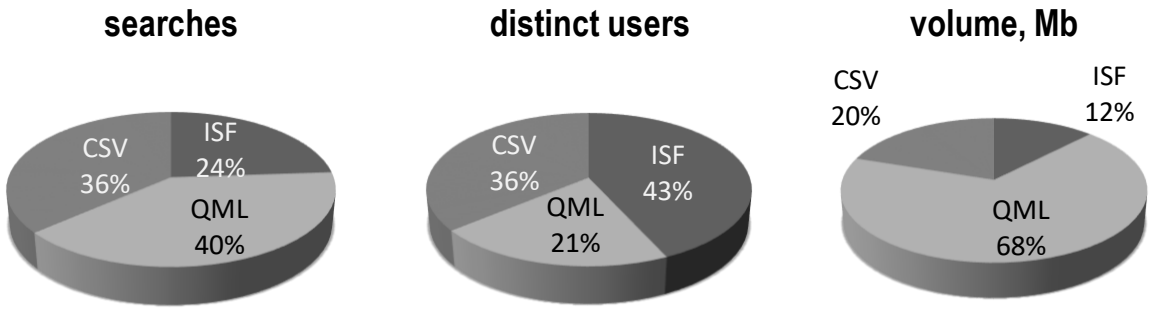


***Figure 18**. Distributions of the number of ISC Bulletin searches, distinct users and overall volume of data taken per output format.*

Printed Summary of the ISC Bulletin

Each issue of the *Summary of the Bulletin of the ISC* covers six months of data. The Summary is prepared at the ISC and printed by *Cambrian Printers* in Wales within approximately two months after the relevant period of ISC data becomes available to users. Then, within a few months the Summary becomes openly available on the web. Physical postage of the Summary books to ISC Members and paying customers usually happens after its publication but has been disrupted during the epidemic. We have recently been posting two issues together once every second issue of each data year was available.

***Figure 19**. The first and second issues of the printed Summary of the Bulletin of the ISC for data year 2018 and the first issue for year 2019 were dealt with during 2021.*

During 2021, we posted the 2018-I issue (published right at the end of year 2020), published and posted the 2018-II issue and published 2019-I issue (Fig. 19). The following topics were covered:

- The ISC (Mandate, History, Evolution of the Bulletin, Member Institutions, Sponsors, Data Contributors, Staff)
- Operational Procedures (data collection, grouping, association, thresholds, location, magnitude determination, review, history of operational changes)
- IASPEI Standards
- Summary of Seismicity (for every 6 months)
- Invited articles on seismic network history, status and procedures (Bolivia and Romania), notable seismic events (Russia) as well as notes from ISC data users (Norway):
    a. National Institute for Earth Physics in *Romania*
    b. Observatorio San Calixto in *Bolivia*
    c. Geophysical Survey and Mining Institute of *Russian* Academy of Sciences

d. University of Bergen in *Norway*

- Statistics of Collected Data
- Overview of the *ISC Bulletin*
- Leading Data Contributors
- Advertisements for instrument producers – Sponsors of the ISC

The invited network description articles become associated with general information available for each agency contributing to the *ISC Bulletin*. Notable event articles become included in the ISC Event Bibliography.

As a book publisher, the ISC charges zero VAT (Value Added Tax) on its printed products and reclaims VAT on all goods and services that it buys from other suppliers.

ISC-EHB

The ISC-EHB dataset (Weston *et al.*, 2018; Engdahl *et al.*, 2020) is a groomed subset of the ISC Bulletin that includes well-recorded events and uses the advantages of both the ISC (Bondar and Storchak, 2011) and EHB (Engdahl *et al.*, 1998) location techniques. Teleseismically well-constrained events are selected from the ISC Bulletin and are relocated using the EHB location algorithms to minimise errors in location (particularly depth) due to assumed 3D Earth structure. The EHB algorithm incorporates a specific phase identification algorithm for teleseismic depth constraining phases (pP, pwP, sP, PcP) and also uses PKiKP, PKPdf, PKPbc and PKPab phases.

During 2021, together with E.R. Engdahl of University of Colorado Boulder, we applied the ISC-EHB approach to events in the year 2018. The ISC-EHB greatly benefitted from the additional depth phase picks made by the ISC analysts using waveforms available at IRIS.

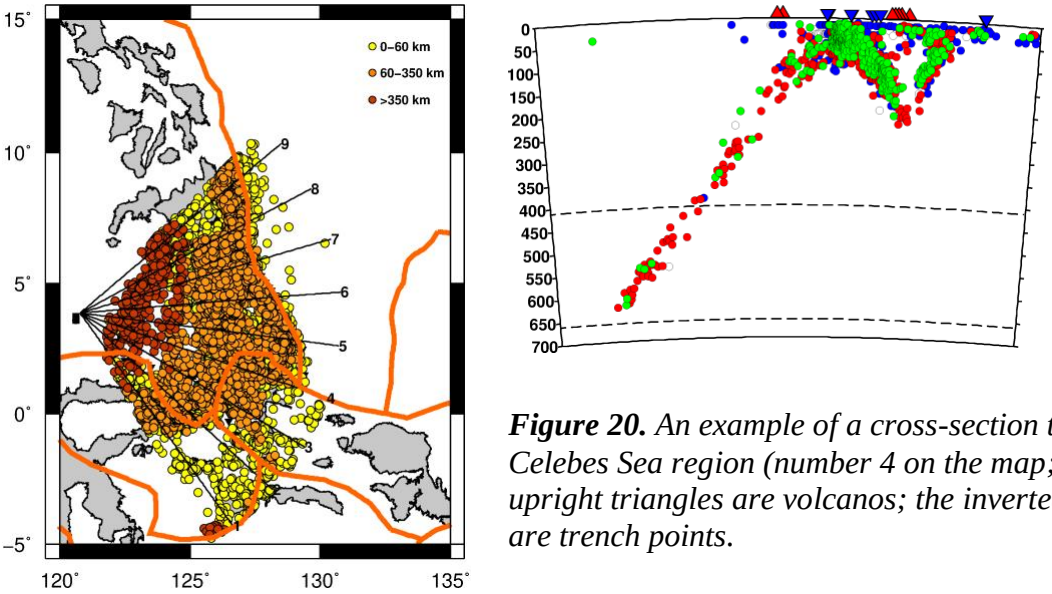


Figure 20. *An example of a cross-section through the Celebes Sea region (number 4 on the map; the upright triangles are volcanos; the inverted triangles are trench points.*

The ISC-EHB dataset has great potential to reveal complicated structures (Fig. 20). It is available from the ISC website along with **cross-section plots** for a large number of seismic regions. The entire dataset (1964-2018) now contains 185,296 seismic events. It is a valuable tool for global and regional seismicity studies and tomographic inversions.

IASPEI REFERENCE EVENT LIST (GT)

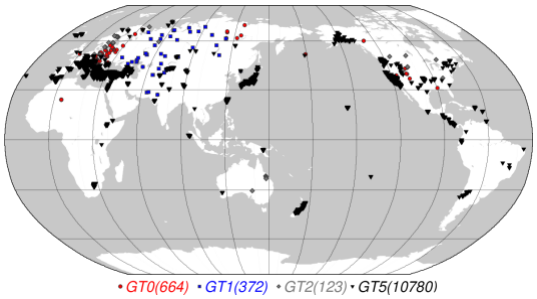


Figure 21a. *The IASPEI List contains seismic events during 1959-2019 for which epicentre information is known with high confidence (to Xkm or better (GTX))*

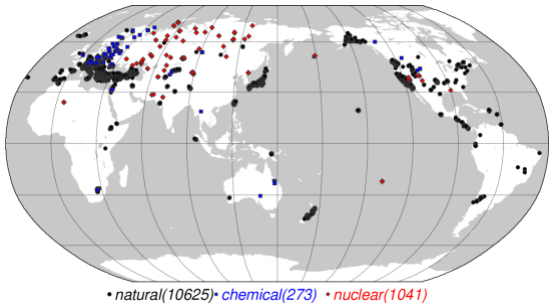


Figure 21b. *The IASPEI List contains natural earthquakes as well as chemical and nuclear explosions.*

The International Seismological Centre maintains the IASPEI database of Reference Events (earthquakes and explosions, including nuclear) for which epicentre information is known with high confidence (to 5km or better, GT5) with seismic signals recorded at regional and/or teleseismic distances (Fig.21a,b). It should be noted that the depth of these events is not known to the same level of accuracy as the epicentre.

The global effort of collecting and validating GT events is coordinated by the CoSOI/IASPEI working group on Reference Events for Improved Location which in 2021 included Bob Engdahl, Eric Bergman, István Bondár, Keith McLaughlin and Ryan Gallacher.

The GT database of 11,939 reference events (1959-2019) and 1,687,971 arrival times facilitates better visualization of the Earth's structure, better modelling of velocities of seismic waves, more accurate travel time determinations and increased accuracy of locations.

The ISC users are able to search this database at the ISC website and receive GT locations and corresponding ISC locations along with station arrival data available for each event. A cross-link to the ISC Bulletin is provided for users to go between ISC and GT databases.

At the end of the analysis of each ISC Bulletin data year, we add new events to the Reference Event List. During 2021, 152 events were added or updated (Fig. 22).

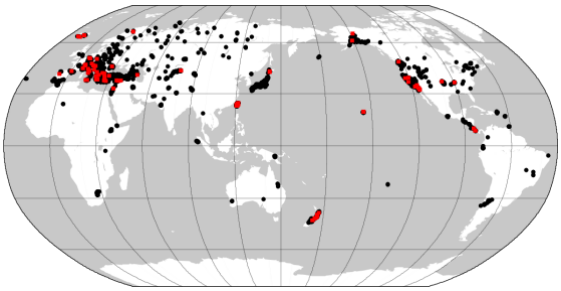


Figure 22. *Events (in red) updated or added to the IASPEI Reference Event List during 2021*

ISC EVENT BIBLIOGRAPHY

The ISC Event Bibliography (Di Giacomo *et al.*, 2014) facilitates an interactive web search for references to scientific publications linked to both natural and anthropogenic events that have occurred in the geographical region of their choice based on earthquake (location, time, etc.) and/or publication parameters (author, journal, year of publication, etc.). The output is presented in a format accepted by major scientific journals. For most recent publications the results include the DOI that facilitates direct access to scientific articles from corresponding journal websites.

References are collected and linked to events in the ISC database based on the titles and abstracts of scientific publications found in the electronic indexes provided by scientific journals as well as references collected during work on the ISC-GEM catalogue.

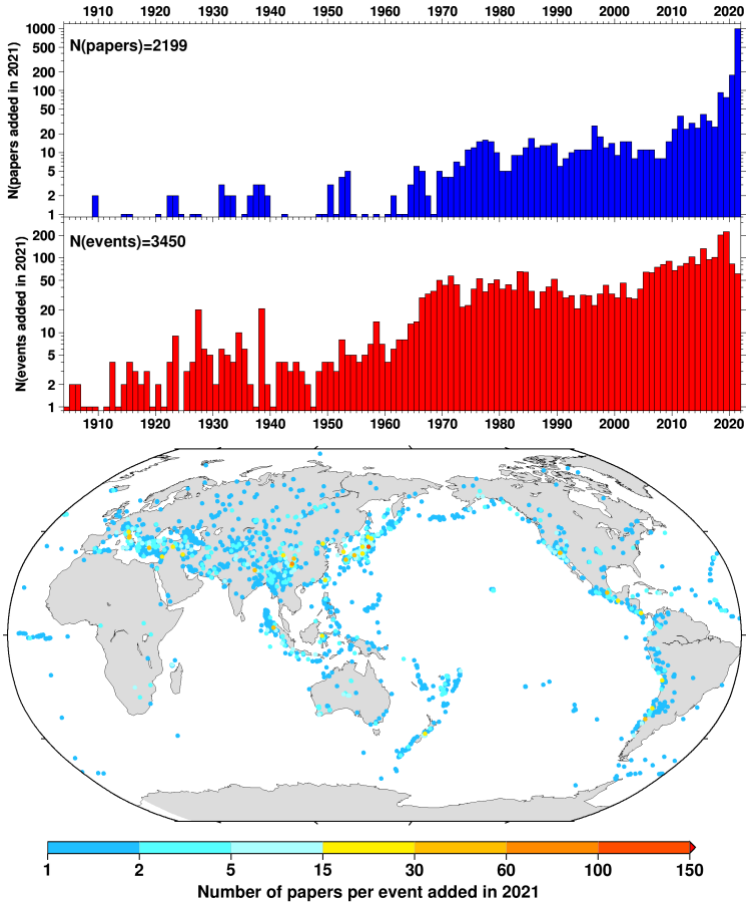


***Figure 23**. Annual numbers and the map of 3,450 seismic events related to 2,199 scientific articles added to the ISC Event Bibliography during 2021.*

Figure 23 illustrates the articles that were added to the Event Bibliography during 2021. A large proportion of this work for the 20th century benefitted from the bibliographical efforts of the ISC staff bringing reliable earthquake source mechanisms and moment tensors into the ISC-GEM catalogue.

SEISMOLOGICAL DATASET REPOSITORY

This relatively new supplementary ISC service (International Seismological Centre, 2021) allows individual researchers or groups to submit seismological datasets that they wish to be openly available to the scientific community for a long period of time. This service assists a

positive trend in scientific publishing to require article authors to make the original research data openly available so that their conclusions can be tested by other researchers.

Examples of acceptable datasets include but are not limited to:

- Event catalogues/bulletins
- Results of earthquake source studies
- Results of structure studies
- Velocity models
- Notable earthquake observations
- Seismological computer code

We do not store raw waveforms as this role falls within the mission of other data centres.

This long-term secure repository of seismic datasets includes all necessary metadata such as a DOI, author contact information, affiliation, relevant scientific publication, and date of submission as well as associated information such as comments, formats, positions of relevant seismic stations etc. The ISC obtains the DOI for each dataset via CrossRef.

The ISC Repository is an open facility that has good potential to serve geophysicists for a very long time. This facility is recognised by scientific journal editors as one of the legitimate independently maintained places for depositing author processed datasets to satisfy editorial board requirements on open access to data.

The Repository received **29** eligible submissions by the end of 2021.

SEISMOLOGICAL CONTACTS

The objective of this project is to maintain up-to-date information on the network of scientific institutions, seismologists and geophysicists, especially in developing countries (Fig. 24), willing to serve as scientific points of contact for:

- Seismologists and Geophysicists in other countries;
- Governments;
- Charitable, Response and Relief organizations;
- Media.

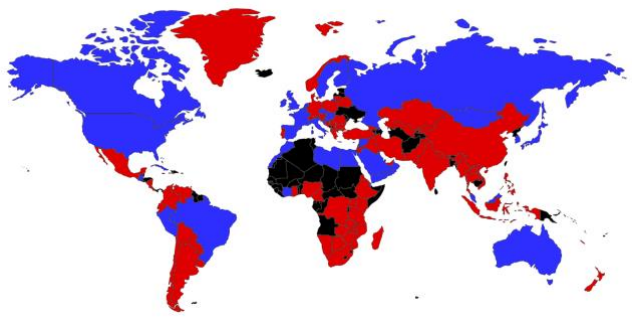


***Figure 24**. Seismological Contacts webpage: in **red** are countries in which institutes and individual staff members are willing to share information and serve as a local point of contact; in **blue** are countries for which we have information about operating geophysical organisation(s); in **black** are countries for which we do not hold any information.*

ISC WEB and FTP SITES

In 2021, the ISC website experienced ~43.7 million hits which is 140% of that in 2020. The majority of the ISC web data are distributed through the main ISC website and the mirror at IRIS DMC in Seattle. The load balancer automatically directs user queries to the least busy server.

The use of the ISC ftp site in 2021 decreased by 12% compared to the previous year. The ftp-site is used for downloading pdf copies of the printed ISC Bulletins and Summaries, the ISC Bulletin in FFB and ISF formats, the ISC-EHB bulletins and the text version of the IR station list. Figure 25 demonstrates worldwide interest in ISC data.

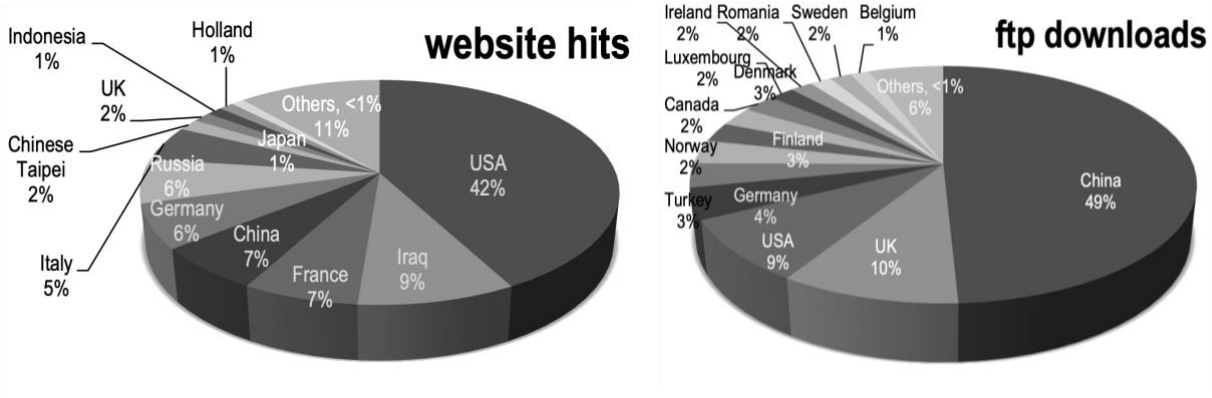


Figure 25. *Per country statistics of ISC website hits (left) and ftp-site downloads (right)*

ISC DATABASE, WEBSITE BACKUP and MIRRORS

The ISC continued maintaining a virtual server at the IRIS DMC in Seattle in order to hold a mirror of the ISC database and the ISC website. This was done with assistance from DMC and US NSF in order to achieve a general ISC data back-up and fall-over facility in case of a breakdown of services at the ISC itself (proved useful when the ISC database server crashed in April 2021) as well as to spread the load on the ISC internet line and give ISC users faster access to data.

The mirror has been operational since 2011. The database in Seattle is updated with approximately an hour time lag. The load balancer evenly distributes the load on the ISC website, including the user searches, between the server at the ISC in Thatcham and the server at DMC in Seattle. Users no longer need to know the exact web address in Seattle and are generally no longer aware which server is addressing their request.

In addition, the IRIS DMC is able to use the database, when required, to serve DMC archive users with event-based selection of waveform data.

Other mirrors of the ISC database are maintained by the Earthquake Research Institution (ERI) of University of Tokyo to serve the research community in Japanese universities, by the Lawrence Livermore National Laboratory (LLNL) to serve users from nuclear test monitoring laboratories in the US and a database mirror and website installed in Beijing and Xian by the China Earthquake Administration (CEA) to help numerous Mandarin speaking seismologists obtain more intuitive access to the ISC data.

5: DEVELOPMENT PROJECTS

ADVANCEMENT of the ISC-GEM CATALOGUE

The ISC-GEM Global Instrumental Catalogue was originally requested and part-funded by the GEM Foundation. The catalogue is widely used for modelling seismic hazard on a regional and global scale. In addition, the catalogue is used as an authoritative reference and a starting point for regional studies in South America, Africa and Asia. The catalogue also has a multidisciplinary use in a wide range of other areas such as studies of global seismicity, tectonics, earthquake hazard forecasting, rapid determination of hazard etc. (Storchak *et al*., 2013, 2015). Moreover, during the ISC-GEM project, we digitised a large volume of basic station observation data (Di Giacomo *et al.*, 2015a; Di Giacomo *et al.*, 2018a) which can now be used by individual researchers for historical earthquake studies. Notably, the ISC-GEM catalogue forms the basis of the USGS's ComCat Catalog (ANSS Catalog) before 1970s.

Year 2021 was the 4th and the last year of the ISC-GEM catalogue *Advancement* project. During this year we relocated ~5900 earthquakes that occurred during 1976-2017 and added 922 earthquakes in 2018 (Fig. 26). Improvements to earthquakes previously listed were done by updating the magnitude and/or location for ~100 earthquakes. We also reprocessed 127 earthquakes between 1964 and 2009 benefiting from the work done in the Rebuild project (Storchak *et al.*, 2017, 2020) and the ISC-EHB dataset (Engdahl *et al.*, 2020).

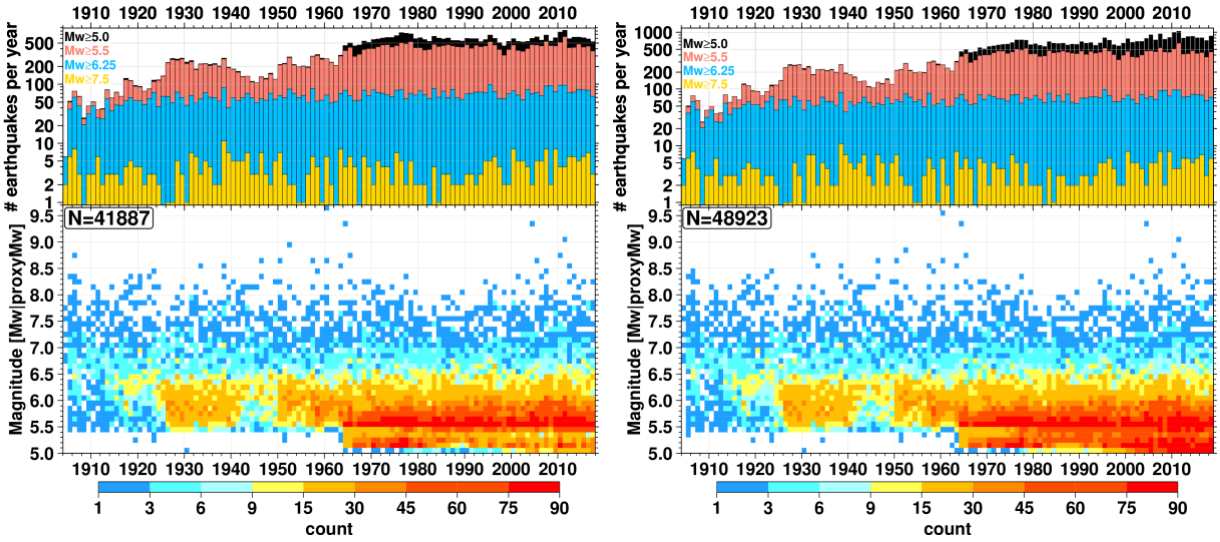


***Figure 26**. Annual number (top) and magnitude distribution (bottom) of earthquakes above a certain magnitude in ISC-GEM Ver.8 (at the end of Year 3 of the Advancement project, left) versus Ver.9 at the end of Year 4 of the Advancement project (right).*

In addition, we sourced from the literature 91 direct M_0 values (hence Mw) and source mechanisms for earthquakes with no GCMT solution (Ekström *et al*., 2012). The results are shown in Figure 27.

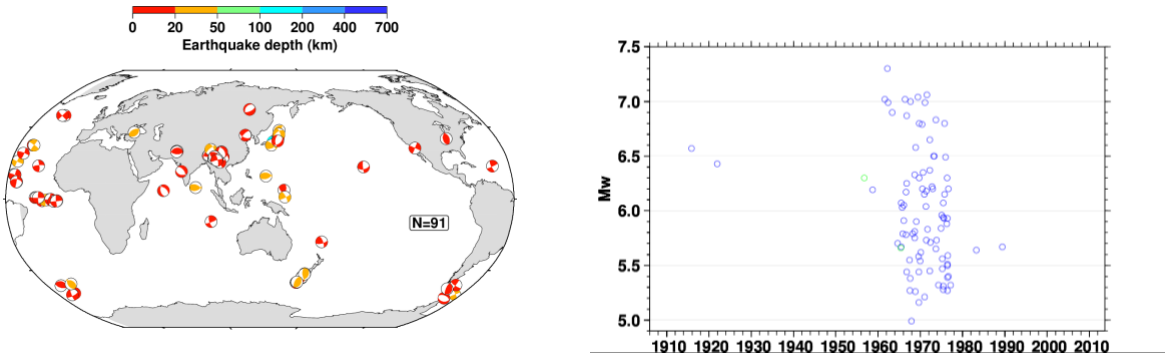


***Figure 27**: Left: 91 earthquakes with source mechanisms added from literature, colour-coded by depth; right: timeline colour-coded by type of source mechanism: blue - broadband (BB), green - first motion polarities (FM).*

The popularity of ISC-GEM has grown over the years (Fig. 28).

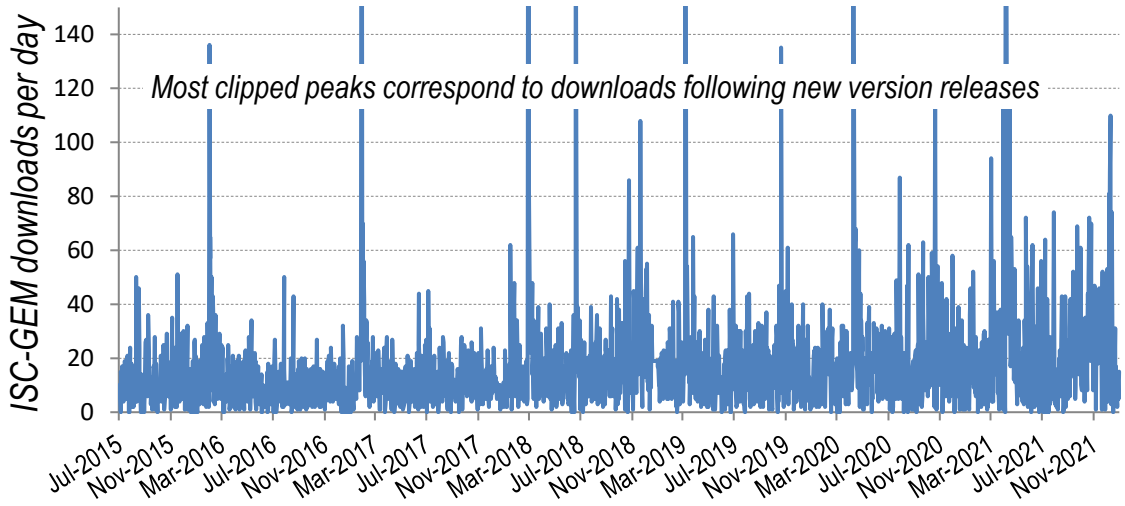


***Figure 28**. During the last 6.5 years, the ISC-GEM catalogue has, on average, been downloaded ~17 times per day; this number increased to ~24 times per day during 2021.*

ELECTRONIC ARCHIVE of PRINTED STATION BULLETINS

In the second half of 2021 we set up a new ISC service – the Electronic Archive of Printed Station / Network Bulletins (ISC, 2022; Di Giacomo *et al.*, 2022). This service has stemmed from our work on the ISC Bulletin and ISC-GEM catalogue.

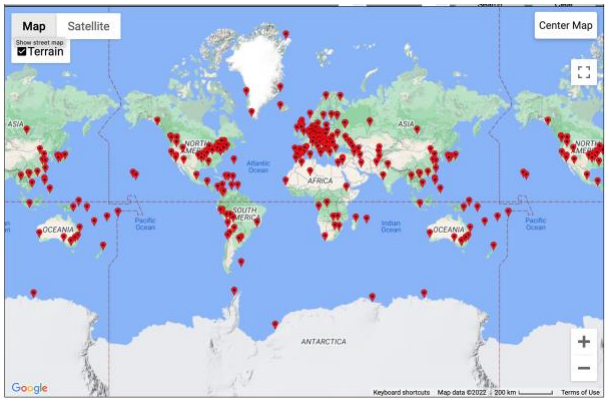


***Figure 29**. The Electronic Archive of Printed Station Bulletins: the towns where paper-based station/network bulletins were produced (among those currently available)*

In this archive users can find scans of printed seismological bulletins. These were the main sources of instrumental parametric data in seismology before the electronic era began. Printed bulletins may contain a single station (e.g., Riverview, Observatorio San Calixto) or a set of stations (network, e.g., as in former USSR from the late 1920s).

The bulletins have been scanned from various sources and have been indexed based on the town where each bulletin was produced. Hence, the town can coincide with the historical station name/location or, as it is often the case, it represents the headquarters of an organization producing the bulletins.

Users can search for bulletin scans by clicking on a town marker, as shown in Figure 29. Next, an inventory of the scans available that were produced at that site is shown with the pdf-copy of each scan freely available to download.

The ISC archive of printed bulletins is not comprehensive, but it is currently the best worldwide service available. We are working with colleagues in other institutions to improve this collection.

IMPROVEMENTS of WAVEFORM DOWNLOAD at the ISC

Multiple processes currently performed by the ISC (i.e. ISC-FM, ISC-PPSM, Depth Phase picking, and CTBTO Link) and those in development (e.g. magnitude calculation) independently download the required waveforms. This inefficiency causes overlapping waveform requests which can result in waveform download for one month taking multiple weeks to complete. Given the increasing amount of waveform processing being undertaken, this independent waveform downloading has become unfeasible. Thus, it is necessary to combine waveform downloading into a single more efficient process which can provide data for all ISC waveform-based procedures and projects. This efficiency is achieved by expanding the current ISC waveform download process which is used mainly for ISC-FM.

ISC waveform download relies on two main structures, Station Availability and Event Selection. Station Availability is based on the successful downloading of response files for a given station in a given time period using the FDSN web service client for ObsPy. We have focused on expanding the stations and channels included in the Station Availability in addition to redesigning how Station Availability is queried.

The ISC currently utilises Z-component waveforms, however, future development projects may require three component waveforms. This requires expanding the station availability check to include additional channels (i.e. XXE, XXN, XX1 & XX2). The additional time required to download these response files proved impractical. This has been solved by first checking for changes in the response file start and end dates without downloading the response file. The process is only completed if the time period does not already have a downloaded response file. This has resulted in an ~20-fold reduction in run time.

Further improvements from this updated process are the removal of station duplication and an opportunity to perform quality control on the downloaded response files. Additionally, by expanding this process (without requiring a response file to be downloaded), accelerometers are now query-able allowing for improved consistency between reported station locations from contributors and the FDSN station locations.

AUTOMATIC ESTIMATION of STANDARD MAGNITUDES

Earthquake magnitudes represent important input to a wide variety of seismological studies ranging from seismic hazard to statistical analysis of seismicity as well as nuclear explosion discrimination. Along with the phase arrival measurements provided by the reporting agencies, the ISC also compiles information about the magnitudes of the events and recomputes different types of magnitudes based on the reported amplitude and period measurements (Bondár and Storchak, 2011; Di Giacomo and Storchak, 2022). Those measurements, however, can be inconsistent between different agencies due to the peculiarities of the waveform processing, such as, differences in filtering limits, measuring the amplitudes within different time windows, applying different instrumental calibration functions etc. To address these inconsistencies, we are developing a procedure for routine automatic estimation of the standard body- and surface-wave magnitudes using publicly available broadband seismological data recorded worldwide. The procedure strictly follows the guidelines by the IASPEI's Commission on Seismic Observation and Interpretation (CoSOI) adopted following the recommendations of the IASPEI Working Group on Magnitude Measurements on new standards for widely used local, regional, and teleseismic magnitude scales (IASPEI 2005, 2013; Bormann and Dewey 2012). Our main goal is to provide uniform characterization of the earthquake size by estimating its magnitude in a consistent and reliable manner.

Among the variety of standard magnitude scales body- and surface-wave magnitudes are the two most common and (historically) important. Following the IASPEI recommendations for the body-wave measurement in the teleseismic distance range (20°-160°) we focus on two complementary standards defining short-period (m_b) and broadband (m_BBB) body-wave magnitudes; both calculated from the maximum trace amplitudes in the entire *P*-phase train (from P-arrival to before PP-phase arrival). For shallow earthquakes with source depth h<60 km IASPEI (2005, 2013) suggests two standards of surface-wave magnitude estimations, namely, a teleseismic (20°-160°), narrowband surface-wave magnitude M_s20 and a broadband surface-wave magnitude M_sBB that is measured in wider epicentral distance and period ranges of 2°-160° and 3s - 60s respectively. The IASPEI guidelines for the amplitude and period measurements for magnitude estimations are transformed into an automated procedure for systematic calculation of the body- and surface-wave magnitudes. The procedure can be summarised as the following: given the origin time and coordinates of an event, available waveform data (BHZ components) from the stations satisfying the epicentral distance conditions and appearing in the ISC Bulletin with *P*- and/or *S*-phase arrival readings are downloaded from the IRIS Data Management Center through the FDSN web service client of ObsPy (Krischer *et al.*, 2015). After the data integrity check and the pre-processing (demeaning and detrending) the broadband traces, proportional to ground velocity, are estimated by removing the instrumental sensitivity and the short- and long-period traces are obtained by applying corresponding WWSSN instrumental responses defined by IASPEI (2013). The amplitude and period measurements for the stations corresponding to the epicentral distance conditions of each magnitude type are carried after the signal-to-noise ratio check (SNR> = 2). For each station, we shall calculate and provide final network magnitudes evaluated as the station's mean. Estimated magnitudes will be reported together with the amplitude, period and phase-time measurements.

We shall confirm that this procedure generally provides estimates that are in good agreement with magnitudes reported in the ISC Bulletin. It provides an automatic scheme for a consistent routine estimation of earthquakes magnitudes that would offer a coherent global

representation of the earthquakes' size and will be further integrated into the ISC Bulletin along with the magnitudes provided by various agencies.

PROBABILISTIC STF, MT and DEPTH INVERTIONS

ISC-PPSM (Probabilistic Point Source Model) (Stähler and Sigloch, 2014, 2016) is a new method introduced at the ISC to address the uncertainty in the earthquake moment tensor that is apparent from the range of moment tensors reported to the ISC, add new constraints on the earthquake source time function (STF), and provide new depth constraints particularly for shallow moderate magnitude earthquakes. An example ISC-PPSM solution is shown in Figure 30.

At the start of 2021, we developed a method of displaying the ISC-PPSM results, including the STF on the website, and supporting full STFs in ISF1.0 and ISF2.1 formats. In 2021, ISC-PPSM became provisionally operational, and throughout the year ISC-PPSM has been running in Beta testing mode, publishing earthquake moment tensors, STFs and depths. In addition, the added depth resolution provided by ISC-PPSM is used to inform the depth of relatively shallow moderate magnitude earthquakes, where depth phase picking is not possible. During this time ISC-PPSM has produced 201 solutions for the time period January-December 2019 that are viewable and downloadable from the ISC website (via the ISC Bulletin), and has been used to directly inform the depths of 30 earthquakes in the ISC Bulletin. To enable the use of ISC-PPSM depths in the main review process, a provisional ISC-PPSM solution is produced before the main review. The ISC-PPSM solution is then re-computed for the revised ISC Bulletin location, and the depths are cross-checked if the ISC-PPSM depth has been used to fix the ISC hypocentre depth.

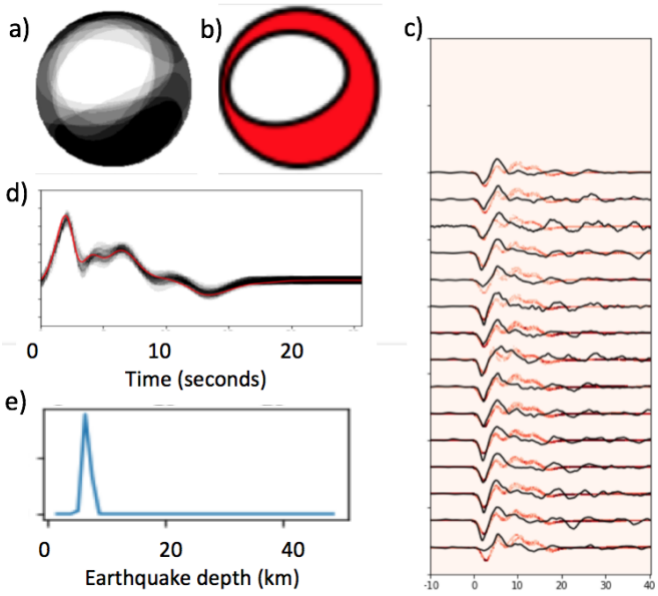


***Figure 30**: Example of the probabilistic STF and moment tensor inversion; **a)** Bayesian beach ball **b)** Best fitting beach ball **c)** Observed seismograms (black) along with ensemble of fitted seismograms (reds) **d)** Probabilistic STF in grey, with best fitting STF in red **e)** Depth probability density function.*

During 2021, ISC-PPSM results have been presented as oral presentations at the SSA and IASPEI meetings, a poster presentation at the AGU Fall Meeting and an invited oral presentation at the ESC.

CTBTO LINK to the ISC DATABASE

In 2008, the UK Foreign and Commonwealth Office (FCO) awarded the ISC a three-year grant to set up a dedicated and secure link to the ISC database for the CTBTO Provisional Technical Secretariat (PTS) and National Data Centres (NDC). The FCO provided 90% of the total funding with GEUS (Denmark), NORSAR (Norway), FOI (Sweden) and University of Helsinki (Finland) complementing it with 2.5% each. From April 2011, the funding of the project was taken over by CTBTO. The previous contract ran from April 2015 until March 2020. A new annual contract has been signed and started in April 2020. It provides a possibility of four annual extensions.

During 2021, we maintained a dedicated server at the ISC that held a mirror version of the ISC database. The dedicated web-based software package designed, maintained and upgraded by the ISC for this service allowed users from the PTS and NDCs at CTBTO to query the ISC database in ways specific to the nuclear test monitoring community. The software package includes four types of bulletin searches: area based, REB event based, GT event based and IMS station based through the wealth of parametric information in the ISC database.

The objective is to provide the capability for NDCs to perform various analysis such as:

- assessing historical seismicity in a specific region;
- putting an event of interest into context with the seismicity of the surrounding region;
- examination of observations reported by non-IMS stations;
- comparison of hypocentre solutions provided by various agencies;
- relocating an REB event based on user selected arrival times available in the ISC database using the *ak135* 1-D model with optional RSTT regional velocity model;
- investigation of station histories and residual patterns of IMS or IMS surrogate stations.

We developed an interface for selecting waveforms of non-IMS stations for REB events from the IRIS DMC, EIDA and GeoNet archives. For recent REB and GT events, this interface:

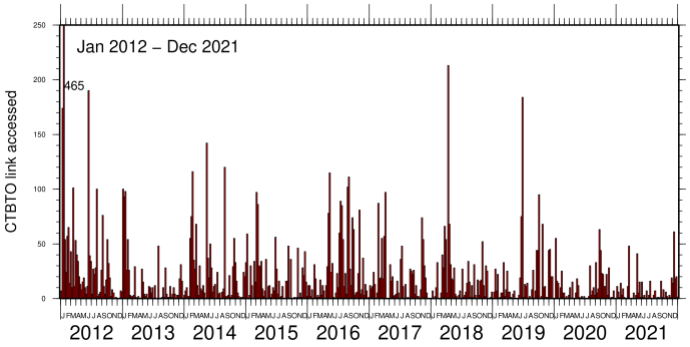


***Figure 31**. The healthy stream of user activities on the IDC/CTBTO Link to the ISC database*

- allows selection of stations by distance / azimuth to the REB epicentre;
- shows the number of stations, for which waveforms are available at all three archives;
- exhibits pre-prepared images of selected waveforms, filtered and un-filtered with theoretical first arrivals indicated on top of the waveform images;
- offers a form to request part of a waveform, based on absolute or relative theoretical arrival times of required seismic phases or on group velocity of surface waves;
- triggers a request to waveform archives; as a result, users receive required waveforms by e-mail in the SEED format.

Figure 31 shows user activity on the Link by both PTS/CTBTO and NDCs.

This project also benefits the ISC and the ISC data users.

- The ISC development staff acquired relevant skills and experience during this project. The advances made under this project are gradually being implemented to improve the open ISC web services. For example, the station histories now form an essential part of the International Seismograph Station Registry, available from the ISC website.
- In particular, experience of downloading, quality checking and processing waveforms on an industrial scale helps the ISC's efforts towards making its own automatic waveform measurements to further improve the quality of the ISC Bulletin.
- The ISC and its Bulletin users have speedy access to the data from the REB Bulletin which is now available in **daily batches within 10-18 days after an event occurrence** as opposed to 6-12 months in the past (Fig. 32).
- Many NDCs are run by institutions that are either Members or Reporters of data to the ISC.
- Several NDC's either became ISC Members or increased their financial contributions, based on the added value of the ISC services.

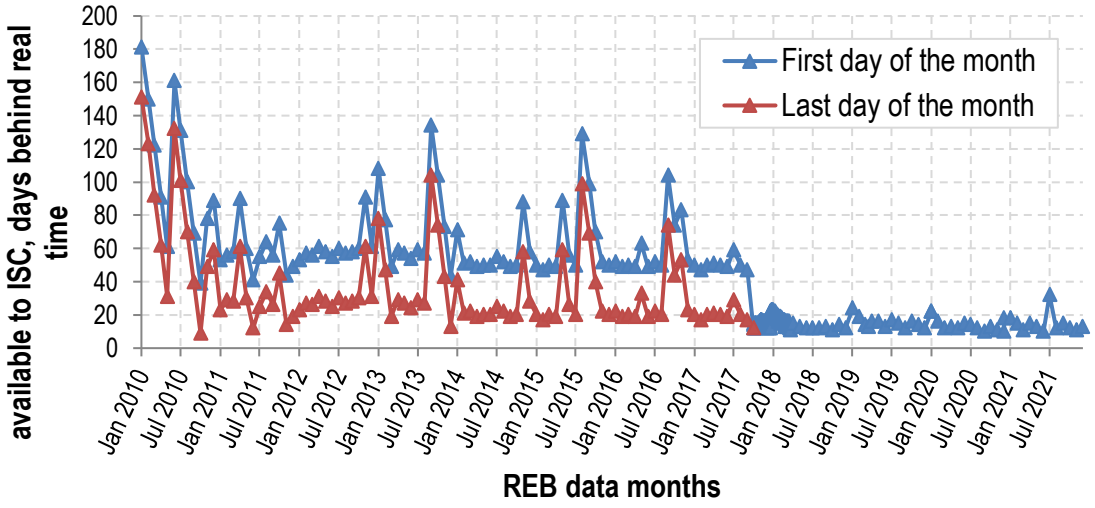


Figure 32*. The availability of data from the ISC REB bulletins (not REB itself) to general ISC Bulletin users (days behind real time) has considerably improved as an indirect result of routine operation of the CTBTO Link; reporting of daily instead of monthly batches made any day of a data month available at the ISC much sooner.*

It also has to be noted that although the use of software created under this project is open only to the monitoring community, the actual data used by them are exactly the same as used by all ISC users: the *ISC Bulletin*, *GT List*, the *ISC-EHB* bulletin and the *International Seismograph Station Registry*.

6: FINANCE

In line with the legal requirement of the Charity Commission for England and Wales, charities with an annual turnover of less than a million pounds are subject to an independent financial examination as opposed to an audit. The detailed financial statements of the ISC for 2021 were originally prepared by Azets Audit Services (Newbury, UK). These statements have then been independently examined by C B Heslop & Company Ltd (Thatcham, UK). These statements present the state of the ISC's financial affairs as at 31st December 2021.

Income

In 2021, the ISC had a total income of £944,054.

The ISC was expecting to receive £722,083 of contributions from 71 Member Institutions in 47 countries. Unfortunately, without any warning, the ***National Centre for Seismology, India*** unilaterally decreased its 2021 contribution from 15 to 10 units quoting the pandemic as the reason. We were forced to treat the missing £11,275 as a bad debt.

Two 1-unit contributions (£4,500 in total) were still delayed on 31st Dec 2020:

- **Icelandic Meteorological Office, *Iceland***
- **Council for Geosciences, *South Africa***

These money has subsequently been paid by the time of producing this report and the annual 2021 Accounts. We praise those Members who pay membership invoices promptly.

During 2021, we welcomed just one new Member:

- Institute of Marine Sciences (ICM-CSIC), Barcelona, *Spain*

Grants for special projects and general sponsorship totalled £217,834, which is **~23%** of the total income.

Traditionally, the income also includes the revenue from sales of the Bulletin Summary book, reduced by the cost of the book and DVD-ROM production and postage, which in 2021 amounted to a loss of £1,234.

We received a rather pitiful £177 of interest on our bank accounts.

Expenditure

As much as 87.5% of ISC expenditure was committed to personnel costs. The staff costs include salaries, pension contributions, and recruitment of new staff. The ISC salaries continue to follow the scales adopted in 2015 and approved by the Executive Committee. Each January, with the approval from the Chairs of the Governing Council and the Executive Committee (Board of Trustees), we increase the staff salaries in line with the annual inflation index (CPI), published by the UK Office of National Statistics. Thus, salaries of all ISC staff were raised by 0.6% from January 2021. We also sustained the continuing rise in pension costs as experienced staff earn an increase in ISC contributions to their pension pots in line with their length of service. Although this measure is costly, it does help to retain good staff.

This year, the staff costs also include additional hours spent by analysts keeping the Bulletin production going whilst working from home. They were also helped by one of the two contractors, L. Brown, working occasional hours from his home in Canada. The costs of the second Contractor, R.E. Engdahl, are accounted for in ISC-EHB project costs.

The staff travel costs stayed extremely low due to the continued Covid-19 pandemic. The building maintenance costs in 2021 were somewhat lower than those in 2020. In addition to regular expenditure, the computer costs in 2021 included the purchase of additional equipment for staff working at home and server replacements for the office. These computer costs were still lower than in 2020.

The exchange rate between UK £ and US $ changed throughout the year. Taking into account the timings of individual incoming and outgoing transactions, the ISC made a gain of £9,931 on foreign currency exchange in 2021.

Reserves

In understanding that all missing contributions will be paid, the ISC's income during 2021 exceeded its expenditure by £48,988, which will help to alleviate the expected austerity period in the post-covid years. As a result, the total reserves, comprising cash in the bank, value of building and land, money owed to the ISC (debtors) minus money the ISC owes (creditors) have increased to £1,300,387 from £1,261,331 at the start of the year when a new valuation of the building and land was taken into account.

Cash Flow

The cash flow in Fig. 33 shows receipts and expenditure using dates when transactions were recorded at the bank and the bank balances where US Dollars are converted to Sterling using the exchange rate at the end of each month.

Due to the size of its General Reserve serving as a safety cushion, the ISC has not experienced problems with its cash flow in 2021. This may change in the future if Members and Sponsors do not provide funds in time. We would like to thank once again those Member-Institutions that make their annual fee payment promptly and accurately when invoices are sent at the beginning of each year.

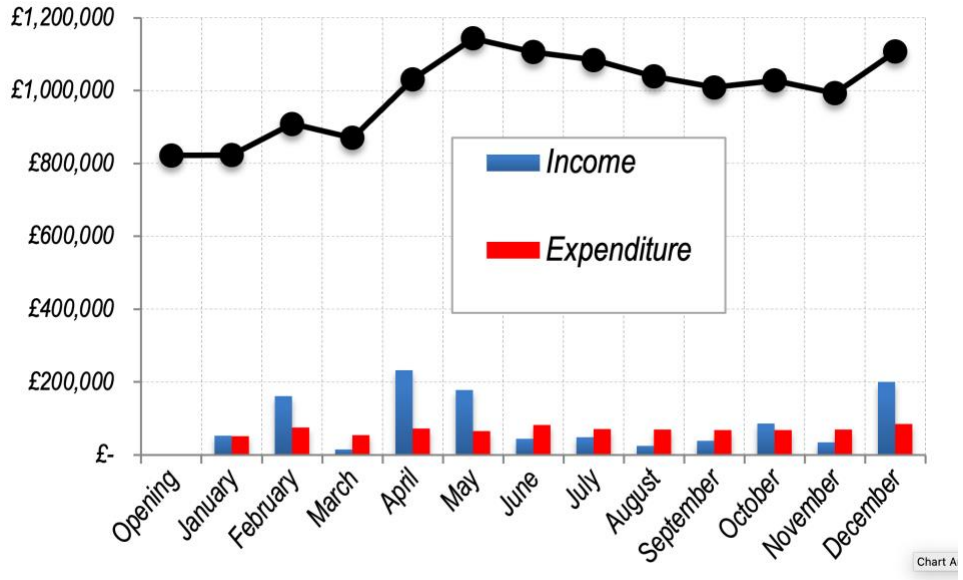


Figure 33. *Income, expenditure and running cash balance at the end of each calendar month during 2021.*

7: SCIENTIFIC COMMUNITY AWARENESS

Visitors to the ISC

Ordinarily, two dozen colleagues visit the ISC each year, meet with the staff and make presentations of their work. Due to the continued global pandemic, the ISC received only one visitor this year – *Dr Peter Charalambidis*, formerly a research and development officer from BG (one of the British oil companies) with expertise in seismic data processing and artificial intelligence methods. Peter works with Tom Garth on improving the algorithms of depth phase pickings and further use.

Conferences, Meetings, Workshops, Training Courses

Members of the ISC staff presented at the following conferences, meetings and workshops that were run predominantly on-line:

- SSA meeting, **virtual**
- SnT CTBTO Conference, **virtual**
- IASPEI Assembly, **virtual**
- ESC Assembly, **virtual**
- GS RAS Scientific Council, **virtual**
- Nordic Seismology Seminar, **virtual**
- GS RAS SeismoSchool, **virtual**
- ORFEUS BoD meeting, Zurich, ***Switzerland***
- Geophysical Monitoring in Far East, Petropavlovsk-Kamchatskij, ***Russia***
- AGU Fall meeting, **virtual**

ISC Staff Visiting Other Institutions

Often with the help of the hosting institution, members of the ISC staff visit and, where appropriate, give a presentation to the staff:

- Kamchatka Branch, Geophysical Survey of Russian Academy of Sciences, Petropavlovsk-Kamchatsky, ***Russia***
- Swiss Seismological Service, Zurich, ***Switzerland***

ISC Prizes: University of Oxford

Several years ago, the ISC established a small annual Prize in Mathematics and Geophysics (£200 and traditional ISC coffee mug) for the best first year student at the Earth Science Department of its Host Institution – the University of Oxford.

This year, the prize was given to Mr Yingbo Li, the student with the best exam results in Mathematics and Geophysics. By awarding this prize the ISC hopes to attract University of Oxford students to take note of the ISC services right from their first year, support the ISC in the future and perhaps even help the ISC in fulfilling its mission.

Scientific Publications by ISC Staff

The ISC staff published several scientific articles during this year to fulfil a general strategy of making the ISC standards, procedures, and services transparent to users. This also helps to keep an historical record of how the ISC data were put together at different times. We also published a few articles that were a result of investigations of notable historical earthquakes with colleagues from other institutions.

Ruch, J., Keir, D., Passarelli, L., Di Giacomo, D., Ogubazghi, G. and Jónsson, S., 2021. Revealing 60 years of earthquake swarms in the southern Red Sea, Afar and the Gulf of Aden. *Frontiers in Earth Science*, 9:664673, https://doi.org/10.3389/feart.2021.664673

Di Giacomo, D. and Sarabia, A.M., 2021. Use of macroseismic and instrumental data to reassess earthquake locations: Examples from pre-digital earthquakes in Colombia. *J. South American Earth Sciences*, 111, 103467, https://doi.org/10.1016/j.jsames.2021.103467

Di Giacomo, D., Harris, J., and Storchak, D. A., 2021. Complementing regional moment magnitudes to GCMT: A perspective from the rebuilt International Seismological Centre Bulletin. *Earth Syst. Sci. Data*, 13, 1957–1985, https://doi.org/10.5194/essd-13-1957-2021

Marimira, K., Manzunzu, B., Shumba, B. T., Midzi, V., and Saunders, I., 2021. Aftershock sequence of 22 September 2016, Manica-Zinave earthquake (Mw5.6), Mozambique. *J. African Earth Sciences*,177, 104146, https://doi.org/10.1016/j.jafrearsci.2021.104146

Lentas, K., 2021. Indications of seismic station phase reversals detected from parametric data in the ISC bulletin. *J Seismol, 25, 1–23*, https://doi.org/10.1007/s10950-020-09960-1

8: REFERENCES

Bondár, I., and D. Storchak, 2011. Improved location procedures at the International Seismological Centre, 2011. *Geophys. J. Int*., 186, 1220-1244.

Bormann, P. and Dewey, J.W., 2012. The new IASPEI standards for determining magnitudes from digital data and their relation to classical magnitudes. In: *New manual of seismological observatory practice 2 (NMSOP-2)*, Deutsches GeoForschungsZentrum GFZ, pp. 1-44.

Di Giacomo, D., Storchak, D.A., Safronova, N., Ozgo, P., Harris, J., Verney, R. and Bondár, I., 2014. A New ISC Service: The Bibliography of Seismic Events, *Seismol. Res. Lett.*, 85, 2, 354-360, doi: 10.1785/0220130143

Di Giacomo, D., Harris, J., Villaseñor, A., Storchak, D.A., Engdahl, E.R., Lee, W.H.K. and the Data Entry Team, 2015a. ISC-GEM: Global Instrumental Earthquake Catalogue (1900-2009), I. Data collection from early instrumental seismological bulletins, *Phys. Earth Planet. Int.*, 239, 14-24, doi: 10.1016/j.pepi.2014.06.003.

Di Giacomo, D., Bondár, I., Storchak, D.A., Engdahl, E.R., Bormann, P., and Harris, J., 2015b. ISC-GEM: Global Instrumental Earthquake Catalogue (1900-2009): III. Re-computed MS and mb, proxy MW, final magnitude composition and completeness assessment, *Phys. Earth Planet. Int.*, 239, 33-47, doi: 10.1016/j.pepi.2014.06.005.

Di Giacomo, D., Engdahl, E. R. and Storchak, D.A., 2018a. The ISC-GEM Earthquake Catalogue (1904–2014): status after the Extension Project, *Earth Syst. Sci. Data*, 10, 1877-1899, doi: 10.5194/essd-10-1877-2018

Di Giacomo, D. and Storchak, D. A., 2022. One hundred plus years of recomputed surface wave magnitude of shallow global earthquakes, *Earth Syst. Sci. Data*, 14, pp. 393–409.

Di Giacomo, D., Olaru, D., Armstrong, A., Harris, J. and Storchak, D. A., 2022. The ISC Electronic Archive of Printed Station and Network Bulletins. Seism. Res. Lett., 93, 2A, 749–752, https://doi.org/10.1785/0220210262

Ekström, G., Nettles, M., and Dziewonski, A.M., 2012. The global CMT project 2004–2010: Centroid-moment tensors for 13,017 earthquakes, *Phys. Earth Planet. Int*., 200-201, 1-9.

Engdahl, E.R., van der Hilst, R. and Buland, R., 1998. Global teleseismic earthquake relocation with improved travel times and procedures for depth determination, *Bull. Seism. Soc. Am.*, 88, 722-743.

Engdahl, E. R., Di Giacomo, D., Sakarya, B., Gkarlaouni, C. G., Harris, J., and Storchak, D. A., 2020. ISC-EHB 1964-2016, an Improved Data Set for Studies of Earth Structure and Global Seismicity, *Earth and Space Science*, 7(1), https://doi.org/10.1029/2019EA000897

Hardebeck, J.L. and Shearer, P.M., 2002. Using S/P Amplitude Ratios to Constrain the Focal Mechanisms of Small Earthquakes. *Bull. Seism. Soc. Am.*, 92 (6), 2264-2276.

Havskov, J., and Ottemöller, L., 1999. SEISAN earthquake analysis software, *Seism. Res. Lett*. 70, 532–534.

Havskov, J., and Ottemöller, L., 2010. Routine Data Processing in Earthquake Seismology, Springer, Dordrecht, The Netherlands, doi: 10.1007/978-90-481-8697-6.

Havskov, J., Voss, P. H. and Ottemöller, L., 2020. Seismological Observatory Software: 30 Years of SEISAN, *Seismol. Res. Lett*. XX, 1–7, doi: 10.1785/0220190313.

IASPEI, 2005. Summary of Magnitude Working Group recommendations on standard procedures for determining earthquake magnitudes from digital data, (available online at http://www.iaspei.org/commissions/CSOI.html).

IASPEI, 2013. Summary of Magnitude Working Group recommendations on standard procedures for determining earthquake magnitudes from digital data, (available online at http://www.iaspei.org/commissions/commission-on-seismological-observation-and-interpretation/Summary_WG_recommendations_20130327.pdf.

International Seismological Centre, 2022. Seismological Dataset Repository, https://doi.org/10.31905/6TJZECEY

International Seismological Centre, 2022. The ISC Electronic Archive of Printed Station/Network Bulletins, https://doi.org/10.31905/GNLY467C

Kennett, B. L. N., Engdahl, E. R., and Buland, R., 1995. Constraints on seismic velocities in the Earth from traveltimes, *Geophys. J. Int*., 122, 108-124.

Krischer, L., Megies, T., Barsch, R., Beyreuther, M., Lecocq, T., Caudron, C., and Wassermann, J., 2015. Obspy: A bridge for seismology into the scientific python ecosystem. *Computational Science & Discovery*, *8*(1), 014003. https://doi.org/10.1088/1749-4699/8/1/014003.

Lentas, K., 2018. Towards routine determination of focal mechanisms obtained from first motion P-wave arrivals, *Geophys. J. Int.*, 212(3), 1665–1686. doi: 10.1093/gji/ggx503

Lentas, K. and Harris, J., 2019. Enhanced performance of ISC focal mechanism computations as a result of automatic first-motion polarity picking optimization, J. Seismol., 1141-1159, https://doi.org/10.1007/s10950-019-09862-x.

Lomax A., Satriano C. and Vassallo M., 2012. Automatic Picker Developments and Optimization: FilterPicker—a Robust, Broadband Picker for Real-Time Seismic Monitoring and Earthquake Early Warning. *Seism. Res. Lett*, 83 (3): 531–540. doi: https://doi.org/10.1785/gssrl.83.3.531

Schweitzer J., Storchak D.A., Borman P., 2019. Seismic Phase Nomenclature: The IASPEI Standard. In: Gupta H. (eds) Encyclopedia of Solid Earth Geophysics. *Encyclopedia of Earth Sciences Series.* Springer, Cham, https://doi.org/10.1007/978-3-030-10475-7

Stähler, S. and Sigloch, K., 2014. Fully probabilistic seismic source inversion-Part 1: Efficient parameterisation. *Solid Earth* (2): 1055-1069.

Stähler, S. C. and Sigloch, K., 2016. Fully probabilistic seismic source inversion-Part 2: Modelling errors and station covariances. *Solid Earth* (6): 1521-1536.

Storchak, D.A., J. Schweitzer, P. Bormann, 2003. The IASPEI Standard Seismic Phase List, *Seismol. Res. Lett.* 74, 6, 761-772.

Storchak, D.A., J. Schweitzer, P. Bormann, 2011. Seismic phase names: IASPEI Standard, in *Encylopedia of Solid Earth Geophysics*, 1162-1173, Ed. H.K. Gupta, Springer.

Storchak, D.A., Di Giacomo, D., Bondár, I., Engdahl, E. R., Harris, J., Lee, W.H.K., Villaseñor, A., and Bormann, P., 2013. Public Release of the ISC-GEM Global Instrumental Earthquake Catalogue (1900-2009). *Seism. Res. Lett.*, 84, 5, 810-815, doi: 10.1785/0220130034.

Storchak, D.A., Di Giacomo, D., Engdahl, E.R., Harris, J., Bondár, I., Lee, W.H.K., Bormann, P., and Villaseñor, A., 2015. The ISC-GEM Global Instrumental Earthquake Catalogue (1900-2009): Introduction, *Phys. Earth Planet. Int.*, 239, 48-63, doi: 10.1016/j.pepi.2014.06.009.

Storchak, D.A., Harris, J., Brown, L., Lieser, K., Shumba, B., Verney, R., Di Giacomo, D., Korger, E. I. M., 2017. Rebuild of the Bulletin of the International Seismological Centre (ISC), part 1: 1964–1979. *Geosci. Lett*. (2017) 4: 32. doi: 10.1186/s40562-017-0098-z

Storchak, D.A., Harris, J., Brown, L., Lieser, K., Shumba, B., Di Giacomo, D., 2020. Rebuild of the Bulletin of the International Seismological Centre (ISC)—part 2: 1980–2010. Geosci. Lett. 7: 18, doi: https://doi.org/10.1186/s40562-020-00164-6

Weston, J., Engdahl, E.R., Harris, J., Di Giacomo, D. and Storchak, D.A., 2018. ISC-EHB: Reconstruction of a robust earthquake dataset, *Geophys. J. Int.*, 24, 1, 474-484, doi: 10.1093/gji/ggy155

APPENDIX 1: STANDARD BULLETIN REPORTERS

150 institutions in 91 countries reported reviewed seismic bulletin data to the ISC during 2021. This number also includes the ISC itself, which now produces depth phase arrival times, polarities of first motions, event source mechanisms, and PPSM in addition to the traditional set of hypocentre solutions and magnitudes.

Albania	The Institute of Seismology, Academy of Sciences of Albania
Algeria	Centre de Recherche en Astronomie, Astrophysique et Geophysique
Argentina	Universidad Nacional de La Plata
Argentina	Instituto Nacional de Prevencion Sismica
Armenia	National Survey of Seismic Protection
Australia	Geoscience Australia
Australia	Curtin University
Austria	International Data Centre, CTBTO
Austria	Zentralanstalt fur Meteorologie und Geodynamik (ZAMG)
Azerbaijan	Republican Seismic Survey Center of National Academy of Sciences
Belgium	Royal Observatory of Belgium

Bolivia	Observatorio San Calixto
Bosnia and Herzegovina	Republic Hydrometeorological Service, Seismological Observatory, Banja Luka
Brazil	Instituto Astronomico e Geofisico, USP
Brazil	Observatory Seismological of the University of Brasilia
Bulgaria	Geophysical Institute, Bulgarian Academy of Sciences
Cameroon	Seismological Observatory of Mount Cameroon
Canada	Canadian Hazards Information Service, Natural Resources Canada
Chile	Centro Sismologico Nacional, Universidad de Chile
China	China Earthquake Networks Center
Chinese Taipei	Institute of Earth Sciences, Academia Sinica
Chinese Taipei	CWB Weather Bureau
Colombia	Red Sismologica Nacional de Colombia
Costa Rica	Seccion de Sismologia, Vulcanologia y Exploracion Geofisica
Croatia	Seismological Survey of the Republic of Croatia
Cuba	Servicio Sismologico Nacional Cubano
Cyprus	Cyprus Geological Survey Department
Czech Republic	The Institute of Physics of the Earth (IPEC)
Czech Republic	Geophysical Institute, Czech Academy of Sciences
Czech Republic	WBNET, Geophysical Institute, Czech Academy of Sciences
Denmark	Geological Survey of Denmark and Greenland
Dominican Rep.	Observatorio Sismologico Politecnico Loyola
Dominican Rep.	Universidad Autonoma de Santo Domingo
DPRK	Korea Earthquake Administration
Ecuador	Servcio Nacional de Sismologia y Vulcanologia
Egypt	National Research Institute of Astronomy and Geophysics
El Salvador	Servicio Nacional de Estudios Territoriales
Finland	Institute of Seismology, University of Helsinki
France	Centre Sismologique Euro-Mediterranen (CSEM/EMSC)
France	Institut de Physique du Globe de Paris
France	Laboratoire de Detection et de Geophysique / CEA
France	EOST / RENaSS
French Polynesia	Laboratoire de Geophysique/CEA
Georgia	Institute of Earth Sciences/ National Seismic Monitoring Center

Germany	Alfred Wegener Institute for Polar and Marine Research
Germany	Bundesanstalt fur Geowissenschaften und Rohstoffe
Germany	Seismological Observatory Berggiesshubel, TU Bergakademie Freiberg
Germany	Geophysikalisches Observatorium Collm
Germany	Helmholtz Centre Potsdam GFZ German Research Centre For Geosciences
Germany	Landeserdbebendienst Baden-Wurttemberg
Greece	National Observatory of Athens
Greece	Department of Geophysics, Aristotle University of Thessaloniki
Greece	University of Patras, Department of Geology
Guatemala	INSIVUMEH
Hong Kong	Hong Kong Observatory
Hungary	KRSZO, Geodetic and Geophysical Research Institute
Iceland	Icelandic Meteorological Office
India	National Geophysical Research Institute
India	National Centre for Seismology of the Ministry of Earth Sciences of India
Indonesia	Badan Meteorologi, Klimatologi dan Geofisika
Iran	Tehran University
Iraq	Iraqi Meteorological and Seismology Organisation
Ireland	Dublin Institute for Advanced Studies
Israel	The Geophysical Institute of Israel / Geological Survey of Israel
Italy	MedNet Regional Centroid - Moment Tensors
Italy	Istituto Nazionale di Geofisica e Vulcanologia
Italy	Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS)
Italy	Laboratory of Research on Experimental and Computational Seismology
Japan	Japan Meteorological Agency
Japan	National Research Institute for Earth Science and Disaster Prevention
Japan	National Institute of Polar Research
Jordan	Jordan Seismological Observatory
Kazakhstan	National Nuclear Center
Kazakhstan	Seismological Experimental Methodological Expedition
Kyrgyzstan	Kyrgyz Seismic Network
Kyrgyzstan	Institute of Seismology, Academy of Sciences of Kyrgyz Republic
Latvia	Latvian Seismic Network

Lebanon	National Council for Scientific Research
Lithuania	Geological Survey of Lithuania
Macao	Macao Meteorological and Geophysical Bureau
Mexico	Centro de Investigacion Cientifica y de Educacion Superior de Ensenada
Mexico	Instituto de Geofisica de la UNAM
Moldova	Institute of Geophysics and Geology
Montenegro	Seismological Institute of Montenegro
Morocco	National Centre for Scientific and Technical Research
Namibia	The Geological Survey of Namibia
Nepal	National Seismological Centre, Nepal
New Caledonia	IRD Centre de Noumea
New Zealand	Institute of Geological and Nuclear Sciences
Nicaragua	Central American Tsunami Advisory Center
North Macedonia	Seismological Observatory Skopje
Norway	University of Bergen
Norway	Stiftelsen NORSAR
Oman	Sultan Qaboos University
Panama	Universidad de Panama
Philippines	Philippine Institute of Volcanology and Seismology
Philippines	Manila Observatory
Poland	Institute of Geophysics, Polish Academy of Sciences
Poland	Private Observatory of Pawel Jacek Wiejacz, D.Sc.
Portugal	Instituto Dom Luiz, University of Lisbon
Portugal	Instituto Portuges do Mar e da Atmosfera, I.P.
Portugal	Sistema de Vigilancia Sismologica dos Azores
Republic of Belarus	Centre of Geophysical Monitoring of the National Academy of Sciences
Republic of Crimea	Inst. of Seismology and Geodynamics, Vernadsky Crimean Federal Uni
Republic of Korea	Korea Meteorological Administration
Romania	National Institute for Earth Physics
Russia	Altai-Sayan Seismological Centre, GS RAS
Russia	Baykal Regional Seismological Centre, GS RAS
Russia	Federal Center for Integrated Arctic Research
Russia	Kola Regional Seismic Centre, GS RAS
Russia	Kamchatkan Branch, GS RAS

Russia	Mining Institute of the Ural Branch of the Russian Academy of Sciences
Russia	Geophysical Survey of Russian Academy of Sciences, Obninsk
Russia	North Eastern Regional Seismological Centre, GS RAS
Russia	Sakhalin Branch, GS RAS
Russia	Institute of Geology, Komi Science Centre, UB, RAS
Russia	Yakutiya Regional Seismological Center, GS RAS
Serbia	Seismological Survey of Serbia
Slovakia	Geophysical Institute, Slovak Academy of Sciences
Slovenia	Slovenian Environment Agency
Spain	Instituto Geografico Nacional
Spain	Institut Cartografic i Geologic de Catalunya
Spain	Real Instituto y Observatorio de la Armada
Switzerland	Swiss Seismological Service (SED)
Trinidad & Tobago	Seismic Research Centre
Tunisia	Institut National de la Meteorologie
Turkey	Disaster and Emergency Management Presidency
Turkey	Kandilli Observatory and Research Institute
U.S.A.	Experimental (GSETT-2) International Data Center
U.S.A.	The Global CMT Project
U.S.A.	IRIS Data Management Center
U.S.A.	National Earthquake Information Center, USGS
U.S.A.	Pacific Northwest Seismic Network
U.S.A.	Pacific Tsunami Warning Center
U.S.A.	Red Sismica de Puerto Rico
U.S.A.	Texas Seismological Network, University of Texas at Austin
Ukraine	Main Centre for Special Monitoring
Ukraine	Subbotin Institute of Geophysics, National Academy of Sciences
UAE	Dubai Seismic Network
United Kingdom	British Geological Survey
United Kingdom	International Seismological Centre
Uzbekistan	Institute of Seismology, Academy of Sciences
Venezuela	Fundacion Venezolana de Investigaciones Sismologicas
Vietnam	National Center for Scientific Research
Zimbabwe	Goetz Observatory

APPENDIX 2: ISC DATA in RESEARCH PUBLICATIONS

This list is a result of a special effort to put together a collection of scientific papers published during 2021 that used ISC data. The list is by no means exhaustive. The ISC has become such a familiar name that many researchers sadly fail to reference their use of the ISC data.

To track publications that use one or more of the ISC dataset and services, we set up automatic alerts with Google Scholar for scientific papers that refer to ISC. The Google Scholar alerts return matches with different ways to refer to the ISC as normally done by authors, such as "International Seismological Centre", "International Seismological Center", "ISC-GEM", "ISC-EHB" and "EHB" + "seismic". No doubt many more references can be found by using different search phrases. Below are the bibliographic references to the 331 works in year 2021 as gathered by Google Scholar. The references to articles published in journals are listed first, followed by the references to other types of publications (e.g., chapters in books, reports, thesis, websites). The references are sorted by journal name. The vast majority of the references below belong to journal articles.

Annual number of citations have been growing over the last few years since this tracking procedure was set up (Fig.34).

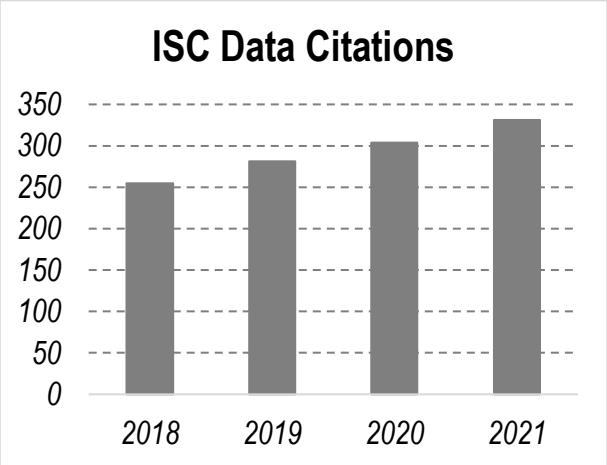


Figure 34. *Growing annual number of ISC data citations in scientific publications*

D'Ajello Caracciolo, F. and Console, R. (2021). Earthquake location in tectonic structures of the Alpine Chain: the case of the Constance Lake (Central Europe) seismic sequence, Acta Geophys., 69, 4, 1163-1175, DOI: 10.1007/s11600-021-00594-6

Khalil, U., Aslam, B. and Maqsoom, A. (2021). Afghanistan earthquake 2015 aftershocks analysis for a better understanding of the seismicity behavior for future assessment, Acta Geophys., 69, 4, 1189-1197, DOI: 10.1007/s11600-021-00624-3

Elmas, A. (2021). Tectonic and crustal structure of the Eastern Pontides using Bouguer gravity data, Acta Geophys., 69, 5, 1637-1650, DOI: 10.1007/s11600-021-00640-3

Gnyp, A. and Malytskyy, D. (2021). Differential and source terms locations of the 2015 Teresva (East Carpathians) series and their tectonic implications, Acta Geophys., 69, 6, 2099-2112, DOI: 10.1007/s11600-021-00655-w

Amiri Khamkani, H., Tavakoli Chatroodi, M.R. and Bahrampour, A. (2021). A method to estimate the maximum stress time in a fault zone before an earthquake, Acta Geophys., 69, 6, 2145-2159, DOI: 10.1007/s11600-021-00651-0

Nana, G.V., Lepatio Tchieg, S.A., Ntomb Biboum, E.O., Fosso Teguia, E.E.M., Nguiya, S. and Tokam Kamga, A.P. (2021). Preliminary study of seismic hazard along the Cameroon Volcanic Line, American Journal of Earth Sciences, 8, 1, 1-10

Ghosh, U. and BhattacharyaP.M. (2021). Seismic Hazards Assessment in the Eastern Himalayas Region, American Journal of Environmental Science and Engineering, 2021, 95-103, DOI: 10.11648/j.ajese.20210504.13

Cucci, L. (2021). The resizing of the most powerful Italian instrumental earthquake (September 8, 1905, Calabria region, Southern Italy), Annls Geophys., 64, 6, SE658, DOI: 10.4401/ag-8675

Pasari, S., Sharma, Y. and Neha (2021). Quantifying the current state of earthquake hazards in Nepal, Applied Computing and Geosciences, 10, 100058, DOI: 10.1016/j.acags.2021.100058

Krylov, A.A., Alekseev, D.A., Kovachev, S.A., Radiuk, E.A. and Novikov, M.A. (2021). Numerical Modeling of Nonlinear Response of Seafloor Porous Saturated Soil Deposits to SH-Wave Propagation, Applied Sciences, 11, 4, 1854, DOI: 10.3390/app11041854

Kadiri, U.A. and Amponsah, P.E. (2021). Computation of area-characteristic seismicity parameters in Ghana, Nigeria, and immediate neighbors, Arabian J. Geosci., 14, 1213, DOI: 10.1007/s12517-021-07558-6

Motaghed, S., Khazaee, M. and Mohammadi, M. (2021). The b-value estimation based on the artificial statistical method for Iran Kope-Dagh seismic province, Arabian J. Geosci., 14, 15, DOI: 10.1007/s12517-021-07970-y

Ahmed, J., Javed, F., Zafar, W., Iqbal, T. and Shah, M. (2021). Spatial variation of b-value, creep rate, and seismic moment release along Chaman fault system, Arabian J. Geosci., 14, 16, DOI: 10.1007/s12517-021-08032-z

Haider, A. and Rehman, Z. (2021). Evaluation of seismicity of Karachi city in the context of modern building codes, Arabian J. Geosci., 14, 2, DOI: 10.1007/s12517-021-06462-3

Arimuko, A. and Sianipar, D. (2021). Source study of the 1996 MW 8.2 Biak (Papua, Indonesia) earthquake: relations to regional tectonics and directivity effect, Arabian J. Geosci., 14, 20, DOI: 10.1007/s12517-021-08560-8

Kazmi, Z.A., Konagai, K., Maqsoom, A., Sodangi, M., Qureshi, M.U. and Abuhajar, O. (2021). Co-seismic stress changes and triggering mechanism of earthquake-induced landslides: a case of 2005 Kashmir earthquake, Arabian J. Geosci., 14, 21, DOI: 10.1007/s12517-021-08514-0

Lewerissa, R., Rumakey, R., Syakur, Y.A. and Lapono, L. (2021). Completeness magnitude (Mc) and b-value characteristics as important parameters for future seismic hazard assessment in the West Papua province Indonesia, Arabian J. Geosci., 14, 23, DOI: 10.1007/s12517-021-08885-4

Jarraya, E., Montassar, S., Ben Mekki, O. and Hamdi, H. (2021). Probabilistic seismic hazard assessment for two potential nuclear power plant sites in Tunisia, Arabian J. Geosci., 14, 3, DOI: 10.1007/s12517-021-06536-2

Abdelrahman, K., Al-Amri, A., Fnais, M., Qaysi, S., Abdelfattah, A. and Al-Otaibi, N. (2021). Site effect and microzonation of the Jizan coastal area, southwestern Saudi Arabia, for earthquake hazard assessment based on the geotechnical borehole data, Arabian J. Geosci., 14, 8, DOI: 10.1007/s12517-021-07049-8

Ndibi, E.D.D., Mbossi, E.F., Wokwenmendam, N.P., Ateba, B. and Ndougsa-Mbarga, T. (2021). Probabilistic seismic hazard assessment for the main cities along the continental section of the Cameroon volcanic line, Arabian J. Geosci., 14, 9, DOI: 10.1007/s12517-021-07033-2

Makrem, H. (2021). Seismicity and active stress field derived from the inversion of focal mechanism data, South Atlas of Tunisia, Arabian J. Geosci., 14, 1395, DOI: 10.1007/s12517-021-07802-z

Harzali, M., Medhioub, E., Troudi, H. and Bouaziz, S. (2021). The Aqaba Earthquake, 22 November 1995 (7.3 Mw): insights on the seismicity and active faulting of Gulf of Aqaba, Arabian J. Geosci., 14, 1915, DOI: 10.1007/s12517-021-08252-3

Khan, M.Y., Shah, M.A. and Khanam, F. (2021). Earthquake stochastic modeling and estimating the probabilities of earthquake occurrences in Hindu Kush region, Arabian J. Geosci., 14, 222, DOI: 10.1007/s12517-020-06412-5

Satyannarayana, R. and Rajesh, B.G. (2021). Seismotectonic map and seismicity parameters for Amaravati area, India, Arabian J. Geosci., 14, 2414, DOI: 10.1007/s12517-021-08622-x

Yegane, A.G., Solgi, A., Uromeie, A., Maleki, Z. and Nezafati, N. (2021). Calculation of seismicity parameters and strong ground movement in Lorestan province (Boroujerd city) based on seismic data, Arabian J. Geosci., 14, DOI: 10.1007/s12517-021-07675-2

Rahman, A., Rasheed, A., Najam, F.A., Zaman, S., Rana, I.A., Aslam, F. and Khan, S.U. (2021). An Updated Earthquake Catalogue and Source Model for Seismic Hazard Analysis of Pakistan, Arabian Journal for Science and Engineering, 46, 5, 5219-5241, DOI: 10.1007/s13369-021-05439-4

Khan, M.J., Lamessa, G., Ali, M. and Khan, M. (2021). An Updated Catalog of Earthquakes for Southern Pakistan and Surrounding Offshore Region, Arabian Journal for Science and Engineering, 47, 1, 601-617, DOI: 10.1007/s13369-021-05575-x

Nikulins, V. and Malytskyy, D. (2021). Focal mechanism of the Kaliningrad earthquake of 21 September 2004 based on waveform inversion using a limited number of stations, Baltica, 34, 1, 95-107, DOI: 10.5200/baltica.2021.1.8

Quintero-Quintero, R., Campos-Durán, D., Porras-Espinoza, H. and Segura-Torres, J. (2021). Análisis de sismos interplaca, Pacifíco Central de Costa Rica: Los

sismos de Esterillos (13 de noviembre de 2017) y Herradura (24 de agosto de 2020), Boletín de la Sociedad Geológica Mexicana, 73, 2, DOI: 10.18268/BSGM2021v73n2a100121

Duverger, C., Mazet-Roux, G., Bollinger, L., Guilhem Trilla, A., Vallage, A., Hernandez, B. and Cansi, Y. (2021). A decade of seismicity in metropolitan France (2010-2019):the CEA/LDG methodologies and observations, BSGF - Earth Sciences Bulletin, 192, 25, DOI: 10.1051/bsgf/2021014

Bozzoni, F., Cantoni, A., De Marco, M.C. and Lai, C.G. (2021). ECLiq: European interactive catalogue of earthquake-induced soil liquefaction phenomena, Bull. Earthquake Eng., 19, 12, 4719-4744, DOI: 10.1007/s10518-021-01162-5

Rahman, A., Najam, F.A., Zaman, S., Rasheed, A. and Rana, I.A. (2021). An updated probabilistic seismic hazard assessment (PSHA) for Pakistan, Bull. Earthquake Eng., 19, 4, 1625-1662, DOI: 10.1007/s10518-021-01054-8

Slejko, D., Rebez, A., Santulin, M., Garcia-Pelaez, J., Sandron, D., Tamaro, A., Civile, D., Volpi, V., Caputo, R., Ceramicola, S., Chatzipetros, A., Daja, S., Fabris, P., Geletti, R., Karvelis, P., Moratto, L., Papazachos, C., Pavlides, S., Rapti, D., Rossi, G., Saraò, A., Sboras, S., Vuan, A., Zecchin, M., Zgur, F. and Zuliani, D. (2021). Seismic hazard for the Trans Adriatic Pipeline (TAP). Part 1: probabilistic seismic hazard analysis along the pipeline, Bull. Earthquake Eng., 19, 9, 3349-3388, DOI: 10.1007/s10518-021-01111-2

Ansari, S. (2021). Structural and stress heterogeneities along the 1997 Zirkuh earthquake fault, Eastern Iran, Bull. Eng. Geol. Environ., 80, 11, 8319-8337, DOI: 10.1007/s10064-021-02436-7

Badrolhisham, S.N.S. and Latiff, A.H.A. (2021). Integrated Seismic Hazard Analysis Of Southwest Penang Island Through Horizontal-To-Vertical Spectral Ratio And Probabilistic Seismic Hazard Assessment, Bulletin of the Geological Society of Malaysia, 71, 79-87, DOI: 10.7186/bgsm71202107

Carlton, B. and Kaynia, A.M. (2021). PSHA Compatible Probabilistic Seismic Site Response Analysis for Oslo, Norway, Bull. seism. Soc. Am., 111, 1, 206-225, DOI: 10.1785/0120200089

Sukhovich, A., Perrot, J. and Royer, J.-Y. (2021). Using Teleseismic P-Wave Arrivals to Calibrate the Clock Drift of Autonomous Underwater Hydrophones, Bull. seism. Soc. Am., 111, 1, 21-35, DOI: 10.1785/0120200217

de Melo, G.W.S., Parnell-Turner, R., Dziak, R.P., Smith, D.K., Maia, M., do Nascimento, A.F. and Royer, J. (2021). Uppermost Mantle Velocity beneath the Mid-Atlantic Ridge and Transform Faults in the Equatorial Atlantic Ocean, Bull. seism. Soc. Am., 111, 2, 1067-1079, DOI: 10.1785/0120200248

Tape, C., Sykes, L. and Lomax, A. (2021). The 1900 Mw 7.6--8.0 Earthquake Offshore of Kodiak Island, Alaska, Bull. seism. Soc. Am., 111, 2, 1080-1109, DOI: 10.1785/0120200273

Chhangte, R.L., Rahman, T. and Wong, I.G. (2021). Ground-Motion Model for Deep Intraslab Subduction Zone Earthquakes of Northeastern India (NEI) and Adjacent Regions, Bull. seism. Soc. Am., 111, 2, 932-950, DOI: 10.1785/0120200050

Mariniere, J., Beauval, C., Nocquet, J.-M., Chlieh, M. and Yepes, H. (2021). Earthquake Recurrence Model for the Colombia-Ecuador Subduction Zone Constrained from Seismic and Geodetic Data, Implication for PSHA, Bull. seism. Soc. Am., 111, 3, 1508-1528, DOI: 10.1785/0120200338

Anderson, J.G., Biasi, G.P., Angster, S. and Wesnousky, S.G. (2021). Improved Scaling Relationships for Seismic Moment and Average Slip of Strike-Slip Earthquakes Incorporating Fault-Slip Rate, Fault Width, and Stress Drop, Bull. seism. Soc. Am., 111, 5, 2379-2392, DOI: 10.1785/0120210113

Park, S., Hong, T.-K. and Rah, G. (2021). Seismic Hazard Assessment for the Korean Peninsula, Bull. seism. Soc. Am., 111, 5, 2696-2719, DOI: 10.1785/0120200261

Chen, Q.-F., Wang, X., Jing-Zhong, J. and Li, T.-J. (2021). The Northwest Pacific subduction zone and its deep earthquake activity, Chinese J. Geophys., 64, 12, 4394-4405, DOI: 10.6038/cjg2021P0038

Liu, J.-Q., Gan, W.-J., Wang, G.-M., Wang, Z.-L., Zhang, Y., Cai, H.-L. and Li, Z.-W. (2021). Seismic moment tensor and seismogenic structure of the Yangbi MS 6.4 earthquake sequence on May 21, 2021 in Yunnan, Chinese J. Geophys., 64, 12, 4475-4487, DOI: 10.6038/cjg2021P0559

Isse, T., Suetsugu, D., Ishikawa, A., Shiobara, H., Sugioka, H., Ito, A., Kawano, Y., Yoshizawa, K., Ishihara, Y., Tanaka, S., Obayashi, M., Tonegawa, T. and Yoshimitsu, J. (2021). Seismic evidence for a thermochemical mantle plume underplating the lithosphere of the Ontong Java Plateau, Communications Earth \& Environment, 2, 1, DOI: 10.1038/s43247-021-00169-9

Bertil, D., Mercury, N., Doubre, C., Lemoine, A. and Van der Woerd, J. (2021). The unexpected Mayotte 2018–2020 seismic sequence: a reappraisal of the regional seismicity of the Comoros, Comptes Rendus Géoscience, 353, S1, 1-25, DOI: 10.5802/crgeos.79

Delouei, M.N. and Gheitanchi, M.-R. (2021). Determination of spectral decay parameter and Quality factor in Kermanshah region, NW Iran, Contrib. Geophys. Geod., 51, 2, 129-139, DOI: 10.31577/congeo.2021.51.2.2

Tiwari, R.K. and Paudyal, H. (2021). Statistics of the earthquakes in the central Himalaya and its vicinity in last 56 years, with an emphasis in the 25 April 2015 Gorkha, Nepal earthquake, Contrib. Geophys. Geod., 51, 4, 321-343, DOI: 10.31577/congeo.2021.51.4.2

Kopytenko, Y.A., Petrova, A.A., Guriev, I.S., Labetsky, P.V. and Latysheva, O.V. (2021). Analysis of the Informativity of the Earth's Magnetic Field in Near-Earth Space, Cosmic Research, 59, 3, 143-156, DOI: 10.1134/s0010952521030059

Borgohain, H. (2021). Intra-Crustal Seismicity Triggering in Shillong Massif - An Appraisal on Recent Seismicity, Current World Environment, 16, 1, 221-226, DOI: 10.12944/cwe.16.1.22

Jakovlev, A.V., Kovalev, S.M., Shimanchuk, E.V., Shimanchuk, E.V. and Nubom, A.A. (2021). Seismic Network on Drifted Ice Floes: a Case Study in North Barents Sea, Dokl. Earth Sci., 496, 2, 155-159, DOI: 10.1134/s1028334x21020215

Camelo, C.S., Tarazona, S.F.M., de Almeida, M.C.F., de Almeida, M. S.S. and Borges, R.G. (2021). Selection of earthquake ground motion accelerograms for the continental margin of Southeastern Brazil, Dyna, 88, 217, 228-236, DOI: 10.15446/dyna.v88n217.93068

Wu, S., Yao, J., Wei, S., Hubbard, J., Wang, Y., Htwe, Y.M.M., Thant, M., Wang, X., Wang, K., Liu, T., Liu, Q. and Tong, P. (2021). New insights into the structural heterogeneity and geodynamics of the Indo-Burma subduction zone from ambient noise tomography, Earth planet. Sci. Lett., 562, 116856, DOI: 10.1016/j.epsl.2021.116856

Shawn Wei, S., Ruprecht, P., Gable, S.L., Huggins, E.G., Ruppert, N., Gap, L. and Zhang, H. (2021). Along-strike variations in intermediate-depth seismicity and arc magmatism along the Alaska Peninsula, Earth planet. Sci. Lett., 563, 116878, DOI: 10.1016/j.epsl.2021.116878

Xiao, Z., Freymueller, J.T., Grapenthin, R., Elliott, J.L., Drooff, C. and Fusso, L. (2021). The deep Shumagin gap filled: Kinematic rupture model and slip budget analysis of the 2020 Mw 7.8 Simeonof earthquake constrained by GNSS, global seismic waveforms, and floating InSAR, Earth planet. Sci. Lett., 576, 117241, DOI: 10.1016/j.epsl.2021.117241

Katsumata, K. and Nakatani, M. (2021). Testing the seismic quiescence hypothesis through retrospective trials of alarm-based earthquake prediction in the Kurile-Japan subduction zone, Earth Planets Space, 73, 1, DOI: 10.1186/s40623-021-01418-z

Arteta, C.A., Pajaro, C.A., Mercado, V., Montejo, J., Arcila, M. and Abrahamson, N.A. (2021). Ground-motion model for subduction earthquakes in northern South America, Earthq. Spectra, 37, 4, 2419-2452, DOI: 10.1177/87552930211027585

Omran, A., Fahmida, K., Schröder, D., Arnous, M.O., El-Rayes, A.E. and Hochschild, V. (2021). GIS-based rockfall hazard zones modeling along the coastal Gulf of Aqaba Region, Egypt, Earth Sci. Inf., 14, 2, 691-709, DOI: 10.1007/s12145-021-00580-y

Qingyun, D., Fei, T., Yanhui, S., Rui, G., Sanzhong, L., Changmin, F., Guangzeng, W., Feng, L. and Yuyang, T. (2021). Linkage of deep lithospheric structures to intraplate earthquakes: A perspective from multi-source and multi-scale geophysical data in the South China Block, Earth Sci. Rev., 214, 103504, DOI: 10.1016/j.earscirev.2021.103504

Li, J., Ding, W., Lin, J., Xu, Y., Kong, F., Li, S., Huang, X. and Zhou, Z. (2021). Dynamic processes of the curved subduction system in Southeast Asia: A review and future perspective, Earth Sci. Rev., 217, 103647, DOI: 10.1016/j.earscirev.2021.103647

Chen, W.-P. (2021). Spatial patterns of seismogenic faulting in northeastern Asia, Earth Sci. Rev., 220, 103704, DOI: 10.1016/j.earscirev.2021.103704

Kumar, V., Jamir, I., Gupta, V. and Bhasin, R. (2021). Inferring potential landslide damming using slope stability, geomorphic constraints, and run-out analysis: a case study from the NW~Himalaya, Earth Surface Dynamics, 9, 2, 351-377, DOI: 10.5194/esurf-9-351-2021

Jami, M. and Docheshmeh Gorgij, A. (2021). Using the fuzzy inference system and morphometric indices, in finding the vulnerable areas to the earthquake, Environ. Earth Sci., 80, 13, DOI: 10.1007/s12665-021-09751-y

Ansary, M.A. and Jahan, N. (2021). Site response and liquefaction susceptibility estimation of a site in northern part of Bangladesh, Environ. Earth Sci., 80, 23, DOI: 10.1007/s12665-021-10079-w

Bataleva, E. (2021). On the dynamics of the electromagnetic parameters of the Northern Tien Shan lithosphere, EPJ Web of Conferences, 254, 03004, DOI: 10.1051/epjconf/202125403004

Counts, J.W., Jorry, S.J., Vazquez-Riveiros, N., Amy, L.A., Dennielou, E. and Jouet, G. (2021). Sedimentology and distribution of late quaternary calciturbidites and calcidebrites in the Mozambique Channel (Southwest Indian Ocean), Facies, 67, 2, DOI: 10.1007/s10347-021-00624-1

Liu, G., Li, C., Peng, Z., Liu, Y., Zhang, Y., Liu, D., Zhang, M. and Pan, B. (2021). The 2002-2005 Changbaishan Volcanic Unrest Triggered by the 2002 M 7.2 Wangqing Deep Focus Earthquake, Frontiers in Earth Science, 8, 599329, DOI: 10.3389/feart.2020.599329

Basili, R., Brizuela, B., Herrero, A., Iqbal, S., Lorito, S., Maesano, F.E., Murphy, S., Perfetti, P., Romano, F., Scala, A., Selva, J., Taroni, M., Tiberti, M.M., Thio, H.K., Tonini, R., Volpe, M., Glimsdal, S., Harbitz, C.B., Løvholt, F., Baptista, M.A., Carrilho, F., Matias, L.M., Omira, R.,

Babeyko, A., Hoechner, A., Gürbüz, M., Pekcan, O., Yalçıner, A., Canals, M., Lastras, G., Agalos, A., Papadopoulos, G., Triantafyllou, I., Benchekroun, S., Agrebi Jaouadi, H., Ben Abdallah, S., Bouallegue, A., Hamdi, H., Oueslati, F., Amato, A., Armigliato, A., Behrens, J., Davies, G., Di Bucci, D., Dolce, M., Geist, E., Gonzalez Vida, J.M., González, M., Macías Sánchez, J., Meletti, C., Ozer Sozdinler, C., Pagani, M., Parsons, T., Polet, J., Power, W., Sørensen, M. and Zaytsev, A. (2021). The Making of the NEAM Tsunami Hazard Model 2018 (NEAMTHM18), Frontiers in Earth Science, 8, 616594, DOI: 10.3389/feart.2020.616594

Yao, Q., Yang, W., Jiang, X., Guo, Y., Liu, J., Zhang, Y., Wang, H., Ren, J., Yu, C., Yue, C. and Zhao, J. (2021). The 2020 M6.4 Jiashi Earthquake: An Event that Occurred Under the Décollement on the Kaping Fold-and-Thrust Belt in the Southwestern Tien Shan Mountains, China, Frontiers in Earth Science, 9, 647577, DOI: 10.3389/feart.2021.647577

Sajadi, P., Singh, A., Sang, Y.-F., Mukherjee, S. and Chapi, K. (2021). Assessing the key drivers of stream network configuration dynamics for tectonically active drainage basins using multitemporal satellite imagery and statistical analyses, Geocarto International, ahead of print, DOI: 10.1080/10106049.2021.1871668

Chen, H., Li, Z., Luo, Z., Ojo, A.O., Xie, J., Bao, F., Wang, L. and Tu, G. (2021). Crust and Upper Mantle Structure of the South China Sea and Adjacent Areas From the Joint Inversion of Ambient Noise and Earthquake Surface Wave Dispersions, Geochem. Geophys. Geosyst., 22, 3, e2020GC009356, DOI: 10.1029/2020gc009356

Ajorlou, N., Hollingsworth, J., Mousavi, Z., Ghods, A. and Masoumi, Z. (2021). Characterizing Near-Field Surface Deformation in the 1990 Rudbar Earthquake (Iran) Using Optical Image Correlation, Geochem. Geophys. Geosyst., 22, 6, e2021GC009704, DOI: 10.1029/2021GC009704

Ogden, C.S., Keir, D., Bastow, I.D., Ayele, A., Marcou, S., Ugo, F., Woodward, A., Kibret, B.A. and Gudbrandsson, S. (2021). Seismicity and Crustal Structure of the Southern Main Ethiopian Rift: New Evidence From Lake Abaya, Geochem. Geophys. Geosyst., 22, 8, DOI: 10.1029/2021gc009831

Cao, L., He, X., Zhao, L., Lü, C., Hao, T., Zhao, M. and Qiu, X. (2021). Mantle flow patterns beneath the junction of multiple subduction systems between the Pacific and Tethys domains, SE Asia: constraints from SKS-wave splitting measurements, Geochem. Geophys. Geosyst., 22, 9, DOI: 10.1029/2021gc009700

Sianipar, D., Daniarsyad, G., Priyobudi, P., Heryandoko, N. and Daryono, D. (2021). Rupture behavior of the 2017 MW 6.6 Poso earthquake in Sulawesi, Indonesia, Geodesy and Geodynamics, 12, 5, 329-335, DOI: 10.1016/j.geog.2021.07.002

Gordienko, V.V. and Gordienko, L.Y. (2021). P-velocity of the upper mantle, Geofizicheskiy Zhurnal, 43, 2, 152-165, DOI: 10.24028/gzh.v43i2.230194

Gong, W., Jiang, X., Xing, J., Xu, C., Zhang, H., An, L. and Li, C. (2021). Heterogeneous outer-rise seismicity within the Izu-Bonin subduction zone and its tectonic implications, Geological Journal, 56, 9, 4699-4718, DOI: 10.1002/gj.4206

Hazarika, D. and Kayal, J.R. (2021). Recent felt earthquakes (Mw 5.0–5.9) in Mizoram of north-east India region: Seismotectonics and precursor appraisal, Geological Journal, 57, 2, 877-885, DOI: 10.1002/gj.4290

Stamps, D.S., Kreemer, C., Fernandes, R., Rajaonarison, T.A. and Rambolamanana, G. (2021). Redefining East African Rift System kinematics, Geology, 49, 2, 150-155, DOI: 10.1130/g47985.1

Choi, M., Eaton, D.W. and Enkelmann, E. (2021). Is the Eastern Denali fault still active?, Geology, 49, 6, 662-666, DOI: 10.1130/g48461.1

Shi, P., Wei, M. and Pockalny, R.A. (2021). The ubiquitous creeping segments on oceanic transform faults, Geology, 50, 2, 199-204, DOI: 10.1130/g49562.1

Thomaidis, K., Troll, V.R., Deegan, F.M., Freda, C., Corsaro, R.A., Behncke, B. and Rafailidis, S. (2021). A message from the `underground forge of the gods': history and current eruptions at Mt Etna, Geol. Today, 37, 4, 141-149, DOI: 10.1111/gto.12362

Das, R. and Meneses, C. (2021). A unified moment magnitude earthquake catalog for Northeast India, Geomatics Natural Hazards Risk, 12, 1, 167-180, DOI: 10.1080/19475705.2020.1863269

Schlager, U., Jokat, W., Weigelt, E. and Gebhardt, C. (2021). Submarine landslides along the Siberian termination of the Lomonosov Ridge, Arctic Ocean, Geomorphology, 382, 107679, DOI: 10.1016/j.geomorph.2021.107679

Nedaei, M. and Alizadeh, H. (2021). New insights into the 2017 Sefidsang earthquake by Coulomb stress change pattern and aftershock distributions: implication for active tectonics of NE Iran, Geopersia, 11, 1, 23-42, DOI: 10.22059/geope.2020.299725.648538

Moradian-Bajestani, E., Ansari, A. and Karkooti, E. (2021). Local and regional P-wave spectral attenuation model for Iran, Geophys. J. Int., 224, 1, 241-256, DOI: 10.1093/gji/ggaa450

Dougherty, S., Jiang, C., Clayton, R., Schmandt, B. and Hansen, S. (2021). Seismic evidence for a fossil slab origin for the Isabella anomaly, Geophys. J. Int., 224, 2, 1188-1196, DOI: 10.1093/gji/ggaa472

Hazarika, D., Hajra, S., Kundu, A., Bankhwal, M., Kumar, N. and Pant, C. (2021). Imaging the Moho and Main Himalayan Thrust beneath the Kumaon Himalaya:

constraints from receiver function analysis, Geophys. J. Int., 224, 2, 858-870, DOI: 10.1093/gji/ggaa478

Özarpacı, S., Doğan, U., Ergintav, S., Çakır, Z., Özdemir, A., Floyd, M. and Reilinger, R. (2021). Present GPS velocity field along 1999 Izmit rupture zone: evidence for continuing afterslip 20~yr after the earthquake, Geophys. J. Int., 224, 3, 2016-2027, DOI: 10.1093/gji/ggaa560

Zhao, D., Toyokuni, G. and Kurata, K. (2021). Deep mantle structure and origin of Cenozoic intraplate volcanoes in Indochina, Hainan and South China Sea, Geophys. J. Int., 225, 1, 572-588, DOI: 10.1093/gji/ggaa605

Vittori, E., Blumetti, A.M., Valerio, C., Di Manna, P., Piccardi, L., Gega, D. and Hoxha, I. (2021). Geological effects and tectonic environment of the November 26, 2019, Mw 6.4 Durres earthquake (Albania), Geophys. J. Int., 225, 2, 1174-1191, DOI: 10.1093/gji/ggaa582

Iaffaldano, G. (2021). Has the Tibetan Plateau risen in the Early/Mid-Miocene? Constraints from plate-motion reconstructions and seismicity of the Indian Ocean lithosphere, Geophys. J. Int., 225, 2, 1349-1358, DOI: 10.1093/gji/ggab027

Kourouklas, C., Console, R., Papadimitriou, E., Murru, M. and Karakostas, V. (2021). Modelling the large earthquakes recurrence times along the North Aegean Trough Fault Zone (Greece) with a physics-based simulator, Geophys. J. Int., 225, 3, 2135-2156, DOI: 10.1093/gji/ggab085

Stevens, V.L. and Avouac, J.-P. (2021). On the relationship between strain rate and seismicity in the India-Asia collision zone: implications for probabilistic seismic hazard, Geophys. J. Int., 226, 1, 220-245, DOI: 10.1093/gji/ggab098

Porritt, R.W., Becker, T.W., Boschi, L. and Auer, L. (2021). Multiscale, radially anisotropic shear wave imaging of the mantle underneath the contiguous United States through joint inversion of USArray and global data sets, Geophys. J. Int., 226, 3, 1730-1746, DOI: 10.1093/gji/ggab185

Paul, H., Ravi Kumar, M. and Kumar, S. (2021). Evidence for reactivation of new faults and seismicity migration away from the causative fault of the 2001~MW 7.7 Bhuj earthquake, western India, Geophys. J. Int., 226, 3, 1800-1813, DOI: 10.1093/gji/ggab188

Aziz Zanjani, F., Lin, G. and Thurber, C. (2021). Nested regional-global seismic tomography and precise earthquake relocation along the Hikurangi subduction zone, New Zealand, Geophys. J. Int., 227, 3, 1567-1590, DOI: 10.1093/gji/ggab294

Gounon, A., Letort, J., Cotton, F., Weatherill, G., Sylvander, M. and Latour, S. (2021). Improving depth estimations of African earthquakes using teleseismic data, and influence for the East-African rift seismic hazard characterization, Geophys. J. Int., 228, 1, 447-460, DOI: 10.1093/gji/ggab348

Saurel, J.-M., Jacques, E., Aiken, C., Lemoine, A., Retailleau, L., Lavayssière, A., Foix, O., Dofal, A., Laurent, A., Mercury, N., Crawford, W., Lemarchand, A., Daniel, R., Pelleau, P., de Berc, M.B., Dectot, G., Bertil, D., Roullé, A., Broucke, C., Colombain, A., Jund, H., Besançon, S., Guyavarch, P., Kowalski, P., Roudaut, M., Appriou, R., Battaglia, J., Bodihar, S., Boissier, P., Bouin, M.P., Brunet, C., Canjamale, K., Catherine, P., Desfete, N., Doubre, C., Dretzen, R., Dumouche, T., Fernagu, P., Ferrazzini, V., Fontaine, F., Gaillot, A., Géli, L., Griot, C., Grunberg, M., Guzel, E.C., Hoste-Colomer, R., Lambotte, S., Lauret, F., Léger, F., Maros, E., Peltier, A., Vergne, J., Satriano, C., Tronel, F., Van der Woerd, J., Fouquet, Y., Jorry, S.J., Rinnert, E., Thinon, I. and Feuillet, N. (2021). Mayotte seismic crisis: building knowledge in near real-time by combining land and ocean-bottom seismometers, first results, Geophys. J. Int., 228, 2, 1281-1293, DOI: 10.1093/gji/ggab392

Liu, F., Elliott, J.R., Craig, T.J., Hooper, A. and Wright, T.J. (2021). Improving the Resolving Power of InSAR for Earthquakes Using Time Series: A Case Study in Iran, Geophys. Res. Lett., 48, 14, e2021GL093043, DOI: 10.1029/2021gl093043

Jenkins, A.P., Biggs, J., Rust, A.C. and Rougier, J.C. (2021). Decadal Timescale Correlations Between Global Earthquake Activity and Volcanic Eruption Rates, Geophys. Res. Lett., 48, 16, e2021GL093550, DOI: 10.1029/2021gl093550

Gao, Y., Yuan, X., Heit, B., Tilmann, F., Herwaarden, D., Thrastarson, S., Fichtner, A. and Schurr, B. (2021). Impact of the Juan Fernandez Ridge on the Pampean Flat Subduction Inferred from Full Waveform Inversion, Geophys. Res. Lett., 48, 21, e2021GL095509, DOI: 10.1029/2021gl095509

Shen, Z., Zhan, Z. and Jackson, J.M. (2021). Small-Scale Intraslab Heterogeneity Weakens Into the Mantle Transition Zone, Geophys. Res. Lett., 48, 23, e2021GL094470, DOI: 10.1029/2021gl094470

Duncan, N.A., Piazzoli, M.F. and Deinert, M.R. (2021). Predicting Depths of Burst at Denied Access Sites Using Bayesian Data Synthesis, Geophys. Res. Lett., 48, 24, e2021GL094397, DOI: 10.1029/2021gl094397

Sun, B., Kaus, B.J.P., Yang, J., Lu, G., Wang, X., Wang, K. and Zhao, L. (2021). Subduction Polarity Reversal Triggered by Oceanic Plateau Accretion: Implications for Induced Subduction Initiation, Geophys. Res. Lett., 48, 24, e2021GL095299, DOI: 10.1029/2021gl095299

Eizenhöfer, P.R., Glotzbach, C., Büttner, L., Kley, J. and Ehlers, T.A. (2021). Turning the Orogenic Switch: Slab-Reversal in the Eastern Alps Recorded by Low-Temperature Thermochronology, Geophys. Res. Lett., 48, 6, e2020GL092121, DOI: 10.1029/2020gl092121

Irinyemi, S.A., Lombardi, D. and Ahmad, S.M. (2021). Probabilistic seismic hazard assessment for West Africa region, Georisk: Assessment and Management of Risk for Engineered Systems and Geohazards, ahead of print1-15, DOI: 10.1080/17499518.2021.1952608

Papadopoulos, G.A., Agalos, A., Karavias, A., Triantafyllou, I., Parcharidis, I. and Lekkas, E. (2021). Seismic and Geodetic Imaging (DInSAR) Investigation of the March 2021 Strong Earthquake Sequence in Thessaly, Central Greece, Geosciences, 11, 8, 311, DOI: 10.3390/geosciences11080311

Medved, I., Bataleva, E. and Buslov, M. (2021). Studying the Depth Structure of the Kyrgyz Tien Shan by Using the Seismic Tomography and Magnetotelluric Sounding Methods, Geosciences, 11, 122, DOI: 10.3390/geosciences11030122

Pasari, S., Simanjuntak, A.V.H., Neha and Sharma, Y. (2021). Nowcasting earthquakes in Sulawesi Island, Indonesia, Geosci. Lett., 8, 1, DOI: 10.1186/s40562-021-00197-5

Rodkin, M.V. (2021). On the foreshock cascade and extraordinary forecasts in connection with the article by A.I. Malyshev and L.K. Malysheva "Precedent-extrapolation estimate of the seismic hazard in the Sakhalin and the Southern Kurils region", Geosystems of Transition Zones, 5, 2, 128-137, DOI: 10.30730/gtrz.2021.5.2.128-132.133-137

Joshi, L.M., Kotlia, B.S., Kothyari, G.C., Singh, A.K., K. Taloor, A., Upadhyay, R. and Dayal, D. (2021). Neotectonic Landform Development and Associated Mass Movements along Eastern Ramganga Valley in the Kumaun Himalaya, India, Geotectonics, 55, 4, 543-562, DOI: 10.1134/s0016852121040087

Ai, Y., Zhang, J., Dong, M., Wang, B. and Fang, G. (2021). Heat generation effects from shear friction along Xianshui river strike-slip fault in western Sichuan, China, Geothermics, 89, 101936, DOI: 10.1016/j.geothermics.2020.101936

Zhang, Z., Dong, D., Sun, W. and Zhang, G. (2021). The Caroline Ridge fault system and implications for the bending-related faulting of incoming oceanic plateaus, Gondwana Res., 92, 133-148, DOI: 10.1016/j.gr.2020.11.018

Wang, R., Weinberg, R.F., Zhu, D.-C., Hou, Z.-Q. and Yang, Z.-M. (2021). The impact of a tear in the subducted Indian plate on the Miocene geology of the Himalayan-Tibetan orogen, GSA Bulletin, 134, 3-4, 681-690, DOI: 10.1130/b36023.1

Yadav, D.K., Hazarika, D., Kumar, N. and Singh, A.K. (2021). Microseismicity study in the Siang Valley of Arunachal Himalaya: Tectonic Implications of the 2019 Mw 5.9 Mechuka earthquake, Himalayan Geology, 42, 2, 290-298

Muntafi, Y. and Nojima, N. (2021). Seismic properties and fractal dimension of subduction zone in Java and its vicinity using data from 1906 to 2020, International Journal of GEOMATE, 21, 85, 71-83, DOI: 10.21660/2021.85.j2217

Xie, L., Xu, W., Liu, X. and Ding, X. (2021). Surge of Mangla reservoir loading promoted failure on active Décollement of western Himalayas, Int. J. Appl. Earth Obs. Geoinf., 102, 102401, DOI: 10.1016/j.jag.2021.102401

Doski, J.A.H. (2021). Active tectonics along the Sheladiz seismogenic fault in the Western Zagros fold-thrust belt, Kurdistan, Northern Iraq, Int. J. Earth Sci., 110, 2, 595-608, DOI: 10.1007/s00531-020-01973-y

Rodkin, M.V., Andreeva, M.Y. and Liperovskaya, E.V. (2021). Types of strong earthquake precursor behavior obtained from world and regional catalogs of earthquakes, IOP Conference Series: Earth and Environmental Science, 946, 1, 012008, DOI: 10.1088/1755-1315/946/1/012008

Ramthan, A., Abdulnaby, W., Abd, N., Mahdi, H. and Al-Shukri, H. (2021). A Subsurface Geologic Feature Inferred from Relocation of Local Earthquakes in Al-Refaei District, Southern Iraq, Iraqi Geological Journal, 54, 1A, 35-43, DOI: 10.46717/igj.54.1a.4ms-2021-01-25

Syukri, M. (2021). Spatial and Temporal Analysis of b-value Imaging Characteristics Using High Precision Earthquake Spot in the Sumatran Subduction Zone, Iraqi Geological Journal, 54, 2B, 1-11, DOI: 10.46717/igj.54.2b.1ms-2021-08-21

Jaisal, A.K., Gupta, I.D. and Gupta, V.K. (2021). Probabilistic seismic hazard mapping of Northwest India using sources with non-uniform spatial distribution of seismicity, ISET Journal of Earthquake Technology, 57, 3, 556

Shevchenko, V.I., Krupennikova, I.S. and Lukk, A.A. (2021). Stress–Strain State and GPS Kinematics of the Lithosphere in the Northern Part of Eurasia, Izv. Atmos. Oceanic Phys., 57, 10, 1367-1380, DOI: 10.1134/s0001433821100091

Usoltseva, O.A., Ovtchinnikov, V.M. and Krasnoshchekov, D.N. (2021). The Peculiarities of the Earth's Outer-to-Inner Core Transition Zone from the Characteristics of PKIIKP and PKP c-dif Waves, Izv. Phys. Solid Earth, 57, 1, 84-97, DOI: 10.1134/s1069351321010109

Pisarenko, V.F., Lyubushin, A.A. and Rodkin, M.V. (2021). Maximum Earthquakes in Future Time Intervals, Izv. Phys. Solid Earth, 57, 2, 163-179, DOI: 10.1134/s1069351321020099

Shevchenko, V.I., Krupennikova, I.S. and Lukk, A.A. (2021). GPS Kinematics of the Northern Part of the Eurasian Continent and Its Possible Geodynamic

Interpretation, Izv. Phys. Solid Earth, 57, 6, 825-833, DOI: 10.1134/s1069351321060082

Mokrushina, N.G., Tatevossian, R.E. and Vakarchuk, R.N. (2021). 1838 Deep Carpathian Earthquake, Izv. Phys. Solid Earth, 57, 6, 886-893, DOI: 10.1134/s1069351321060057

Kaban, M.K., Delvaux, D., Maddaloni, F., Tesauro, M., Braitenberg, C., Petrunin, A.G. and El Khrepy, S. (2021). Thickness of sediments in the Congo basin based on the analysis of decompensative gravity anomalies, J. Afr. Earth. Sci., 179, 104201, DOI: 10.1016/j.jafrearsci.2021.104201

Kadiri, A.U. and Kijko, A. (2021). Seismicity and seismic hazard assessment in West Africa, J. Afr. Earth. Sci., 183, 104305, DOI: 10.1016/j.jafrearsci.2021.104305

Asefa, J. and Ayele, A. (2021). Seismicity of the East African Rift System for the period 2013 to 2016, J. Afr. Earth. Sci., 183, 104315, DOI: 10.1016/j.jafrearsci.2021.104315

Ezzelarab, M., Ibrahim, K.Y. and Mohamed, A.A. (2021). Earthquake magnitude regression relationships for Sudan territory, J. Afr. Earth. Sci., 183, 104326, DOI: 10.1016/j.jafrearsci.2021.104326

Shah, S.T., Özacar, A.A. and Gülerce, Z. (2021). Fault-based probabilistic seismic hazard assessment of the eastern Makran subduction and the Chaman transform fault, Pakistan: Emphasis on the source characterization of megathrust, J. Asian Earth Sci., 205, 104604, DOI: 10.1016/j.jseaes.2020.104604

Nie, S., Tian, X., Li, J. and Tan, P. (2021). Lithospheric mantle underneath the Tibetan Plateau does not escape southeastward, J. Asian Earth Sci., 206, 104629, DOI: 10.1016/j.jseaes.2020.104629

Mearns, E. and Sornette, D. (2021). A transfer fault complex to explain the geodynamics and faulting mechanisms of the 1976~M7.8 Tangshan earthquake China, J. Asian Earth Sci., 213, 104738, DOI: 10.1016/j.jseaes.2021.104738

Luirei, K., Lokho, K., Longkumer, L., Kothyari, G., Rai, R., Rawat, I. and Nakhro, D. (2021). Morphotectonic evolution of the Quaternary landforms in the Yangui River basin in the Indo-Myanmar Range, J. Asian Earth Sci., 218, 104877, DOI: 10.1016/j.jseaes.2021.104877

Nazari, H., Ritz, J.-F., Burg, J.-P., Shokri, M., Haghipour, N., Vizheh, M.M., Avagyan, A., Nashli, H.F. and Ensani, M. (2021). Active tectonics along the Khazar fault (Alborz, Iran), J. Asian Earth Sci., 219, 104893, DOI: 10.1016/j.jseaes.2021.104893

Pudi, R., Joshi, S., Martha, T., Upadhyay, R. and Pant, C. (2021). A Comprehensive Site Response and Site Classification of the Garhwal-Kumaun Himalaya, Central Seismic Gap (CSG), India, J. Earthq. Eng., ahead of print1-25, DOI: 10.1080/13632469.2021.1927901

Pavankumar, G., Manglik, A., Babu, M.D. and Chakravarthi, N.N. (2021). Magnetotelluric evidence for the presence of a deep electrical conductor in the vicinity of the Delhi Seismic Zone, India, J. Earth Syst. Sci., 130, 2, DOI: 10.1007/s12040-021-01565-7

Pebam, J., Adlakha, V., Jain, A.K., Patel, R.C., Lal, N., Singh, S., Kumar, R. and Devrani, R. (2021). Apatite and zircon fission-track thermochronology constraining the interplay between tectonics, topography and exhumation, Arunachal Himalaya, J. Earth Syst. Sci., 130, 3, DOI: 10.1007/s12040-021-01667-2

Wadhawan, M., Rana, N., Gahalaut, V., Singh, M., Singh, K., Suresh, G., Mishra, O.P., Joshi, A.K., Kulkarni, A.V., Singh, M. and Das, A.K. (2021). Monsoonal rainfall induced shallow earthquake Swarm in the Amravati district of the central India, J. Earth Syst. Sci., 130, 29, DOI: 10.1007/s12040-020-01511-z

Khanban, M.A., Pakzad, M., Mirzaei, N., Moradi, A. and Mehramuz, M. (2021). The present-day stress field in the Zagros Fold-Thrust Belt of Iran, from inversion of focal mechanisms, J. Geodyn., 143, 101812, DOI: 10.1016/j.jog.2020.101812

Debbarma, J. and Debnath, J. (2021). Assessment on the impact of the Tripura earthquake (January 3, 2017, Mw = 5.6) in Northeast India, J. Geogr. Inst. Cvijic, 71, 1, 1-13, DOI: 10.2298/IJGI2101001D

Dinh, T.C., Dinh, T.C., Anh, T.T., Xuan, B.M., Manh, L.N., Van Thanh, D., Le Van, D., Thanh, H.D. and Quang, T.N. (2021). Mapping Seismic Zones Based on the Geomorphic Indices and the Analytic Hierarchy Process (AHP): A Case Study in Cao Bang Province and Adjacent Areas (Vietnam), J. geol. Soc. India, 97, 12, 1565-1573, DOI: 10.1007/s12594-021-1914-9

Liu, S., Suardi, I., Xu, X., Yang, S. and Tong, P. (2021). The Geometry of the Subducted Slab Beneath Sumatra Revealed by Regional and Teleseismic Traveltime Tomography, J. geophys. Res., 126, 1, e2020JB020169, DOI: 10.1029/2020JB020169

Stephenson, J., Tkalčić, H. and Sambridge, M. (2021). Evidence for the Innermost Inner Core: Robust Parameter Search for Radially Varying Anisotropy Using the Neighborhood Algorithm, J. geophys. Res., 126, 1, e2020JB020545, DOI: 10.1029/2020JB020545

Kobayashi, H., Koketsu, K., Miyake, H. and Kanamori, H. (2021). Similarities and Differences in the Rupture Processes of the 1952 and 2003 Tokachi-Oki Earthquakes, J. geophys. Res., 126, 1, DOI: 10.1029/2020jb020585

Yao, J., Liu, S., Wei, S., Hubbard, J., Huang, B.-S., Chen, M. and Tong, P. (2021). Slab Models Beneath Central Myanmar Revealed by a Joint Inversion of Regional and

Teleseismic Traveltime Data, J. geophys. Res., 126, 2, e2020JB020164, DOI: https://doi.org/10.1029/2020JB020164

Pesicek, J.D., Ogburn, S.E. and Prejean, S.G. (2021). Indicators of Volcanic Eruptions Revealed by Global M4+ Earthquakes, J. geophys. Res., 126, 3, e2020JB021294, DOI: 10.1029/2020JB021294

Lü, Y., Liu, J., He, Y. and Guan, Y. (2021). New Uppermost Mantle Pn Velocity and Anisotropy Model of the Eastern Caribbean, J. geophys. Res., 126, 3, DOI: 10.1029/2020jb021523

Furumura, T. and Kennett, B.L.N. (2021). Azimuthal Variation of Lithospheric Heterogeneity in the Northwest Pacific Inferred From Po/So Propagation Characteristics and Anomalously Large Ground Motion of Deep In-Slab Earthquakes, J. geophys. Res., 126, 5, e2021JB021717, DOI: 10.1029/2021jb021717

Liu, H., Gurnis, M. and Leng, W. (2021). Constraints on Mantle Viscosity From Slab Dynamics, J. geophys. Res., 126, 8, DOI: 10.1029/2021jb022329

Li, K., Li, Y., Tapponnier, P., Xu, X., Li, D. and He, Z. (2021). Joint InSAR and field constraints on faulting during the Mw 6.4, 23 July 2020, Nima/Rongma earthquake in central Tibet, J. geophys. Res., 126, 9, e2021JB022212, DOI: 10.1029/2021jb022212

Neharika, G.N.S. and Neelima Satyam, D. (2021). Earthquake scenario selection of Tindharia landslide in India, Journal of Engineering Geology, 46, 1,

Retejum, A. (2021). Warming of Antarctica as a Degassing Consequence, Journal of Geoscience and Environment Protection, 9, 2, 17-41, DOI: 10.4236/gep.2021.92002

Tiwari, R.K. and Paudyal, H. (2021). Box Counting Fractal Dimension and Frequency Size Distributon of Earthquakes in the Central Himalaya Region, Journal of Institute of Science and Technology, 26, 2, 127-136, DOI: 10.3126/jist.v26i2.41664

Ali, S.M., Abdelrahman, K. and Al-Otaibi, N. (2021). Tectonic stress regime and stress patterns from the inversion of earthquake focal mechanisms in NW Himalaya and surrounding regions, Journal of King Saud University - Science, 33, 2, 101351, DOI: 10.1016/j.jksus.2021.101351

Triantafyllou, I., Gogou, M., Mavroulis, S., Lekkas, E., Papadopoulos, G. and Thravalos, M. (2021). The Tsunami Caused by the 30 October 2020 Samos (Aegean Sea) Mw 7.0 Earthquake: Hydrodynamic Features, Source Properties and Impact Assessment from Post-Event Field Survey and Video Records, Journal of Marine Science and Engineering, 9, 1, 68, DOI: 10.3390/jmse9010068

Puhi, A.R., Ariyanto, P., Pranata, B. and Prayitno, B.S. (2021). Crustal Structure Study in Lampung Region Using Teleseismic Receiver Function Analysis, Journal of Physics: Conference Series, 2110, 1, 012002, DOI: 10.1088/1742-6596/2110/1/012002

Bazargan, S., Hossein Shomali, Z. and Rezapour, M. (2021). The 2007 Kahak and 2010 Kazerun earthquakes: constrained non-negative least-squares linear finite fault inversion for slip distribution, Journal of the Earth and Space Physics, ahead of print, DOI: 10.22059/jesphys.2021.303882.1007222

Jalilian, Z., Mahood, M., Heidari, R. and Mehramuz, M. (2021). Evaluation of Earthquake Hazard Parameters by Bayesian Method for Different Source Regions in Zagros Seismotectonic Province, JSEE, 22, 2, 1-16

Terrier-Sedan, M. and Bertil, D. (2021). Active fault characterization and seismotectonic zoning of the Hispaniola island, J. Seismol., 25, 2, 499-520, DOI: 10.1007/s10950-021-09985-0

Yuliastuti, Y., Setiadipura, T., Wicaksono, A.B., Alhakim, E.E., Suntoko, H. and Sunarko, S. (2021). High-resolution probabilistic seismic hazard analysis of West Nusa Tenggara, Indonesia, J. Seismol., 25, 3, 937-948, DOI: 10.1007/s10950-021-10000-9

Morozov, A.N., Vaganova, N.V., Konechnaya, Y.V., Asming, V.E., Dulentsova, L.G. and Evtyugina, Z.A. (2021). Seismicity in the far Arctic areas: Severnaya Zemlya and the Taimyr Peninsula, J. Seismol., 25, 5, 1171-1188, DOI: 10.1007/s10950-021-10032-1

Kværna, T., Gibbons, S.J. and Näsholm, S.P. (2021). CTBT seismic monitoring using coherent and incoherent array processing, J. Seismol., 25, 5, 1189-1207, DOI: 10.1007/s10950-021-10026-z

Sutar, A.K., Roy, S. and Tiwari, V.M. (2021). Revisiting the Koyna-Warna seismic zone: strain budget, present-day potential and associated hazard, J. Seismol., 25, 5, 1265-1279, DOI: 10.1007/s10950-021-10024-1

Nava, F., Despaigne, G. and Glowacka, E. (2021). Poisson renormalized entropy as a possible precursor to large earthquakes, J. Seismol., 25, 6, 1407-1425, DOI: 10.1007/s10950-021-10041-0

Rahman, Z., Rehman, K., Ali, W., Ali, A., Burton, P., Barkat, A., Ali, A. and Qadri, S.M.T. (2021). Re-appraisal of earthquake catalog in the Pamir—Hindu Kush region, emphasizing the early and modern instrumental earthquake events, J. Seismol., 25, 6, 1461-1481, DOI: 10.1007/s10950-021-10046-9

Borah, N., Kumar, A. and Dhanotiya, R. (2021). Seismic source zonation for NE India on the basis of past EQs and spatial distribution of seismicity parameters, J. Seismol., 25, 6, 1483-1506, DOI: 10.1007/s10950-021-10037-w

Irinyemi, S.A., Lombardi, D. and Ahmad, S.M. (2021). Seismic risk analysis for large dams in West Coast basin, southern Ghana, J. Seismol., 26, 1, 101-116, DOI: 10.1007/s10950-021-10045-w

Castro, R.R., Carciumaru, D.D., Collin, M., Vetel, W., Gonzalez-Huizar, H., Mendoza, A. and Pérez-Vertti, A. (2021). Seismicity in the Gulf of California, Mexico, in the period 1901-2018, J. South Amer. Earth Sci., 106, 103087, DOI: 10.1016/j.jsames.2020.103087

Orozco, P.G., Astini, R.A., Presa, J.M., Alvarado, P., Venerdini, A., Rivas, C., Pérez Luján, S., Ortiz, G., Peralta, Y. and Saez, M. (2021). The La Laja spring system in the Argentine Precordillera: A conceptual model based on geochemical and isotopic data, J. South Amer. Earth Sci., 109, 103241, DOI: 10.1016/j.jsames.2021.103241

Rivas, C., Alcacer, J.M., Ortiz, G., Bilbao, I., Ammirati, J.-B., Podesta, M., Alvarado, P., Perucca, L.P. and Perez, I. (2021). Crustal structure of the northern Andean Precordillera, Argentina, based on seismological and gravity data, J. South Amer. Earth Sci., 111, 103478, DOI: 10.1016/j.jsames.2021.103478

Onorato, M.R., Perucca, L.P., Coronato, A., Prezzi, C., Blanc, P.A., López, R. and Magneres, I. (2021). Morphotectonic characterization along the eastern portion of the main trace of Magallanes-Fagnano Fault System in Tierra del Fuego, Argentina, J. South Amer. Earth Sci., 112, 103550, DOI: 10.1016/j.jsames.2021.103550

Febriyanti, Martini, S., Hidajah, A.C. and Dwirahmadi, F. (2021). A study on community economic resilience in response to earthquakes in Jailolo sub-district, North Maluku, Jurnal Berkala Epidemiologi, 9, 2, 105-114, DOI: 10.20473/jbe.v9i22021.105–114

Moreno-Vacas, A. and Almendros, J. (2021). On the origin of recent seismic unrest episodes at Deception Island volcano, Antarctica, J. Volcanol. Geotherm. Res., 419, 107376, DOI: 10.1016/j.jvolgeores.2021.107376

Solomatin, A.V. (2021). The Energy Spectrum of the Seismic Process in Application to Long-Term Earthquake Prediction and Intermediate- and Short-Term Updating of Earthquake Hazard, J. Volcanol. Seismolog., 15, 2, 133-144, DOI: 10.1134/s074204632102007x

Sycheva, N.A. (2021). Crustal Seismotectonic Deformations in Central and Western Tien-Shan, J. Volcanol. Seismolog., 15, 6, 414-434, DOI: 10.1134/s0742046321060105

Meghraoui, M., Toussaint, R. and Aksoy, M.E. (2021). The slip deficit on the North Anatolian Fault (Turkey) in the Marmara Sea: insights from paleoseismicity, seismicity and geodetic data, Mediterranean Geoscience Reviews, 3, 1, 45-56, DOI: 10.1007/s42990-021-00053-w

Rehman, Q., Ahmed, W., Waseem, M., Khan, S., Farid, A. and Shah, S.H.A. (2021). Geophysical investigations of a potential landslide area in Mayoon, Hunza district, Gilgit-Baltistan, Pakistan, Mining-geological-petroleum engineering bulletin, 36, 3, 127-141, DOI: 10.17794/rgn.2021.3.9

Fan, J. and Zhao, D. (2021). Subslab heterogeneity and giant megathrust earthquakes, Nat. Geosci., 14, 5, 349-353, DOI: 10.1038/s41561-021-00728-x

Tsekhmistrenko, M., Sigloch, K., Hosseini, K. and Barruol, G. (2021). A tree of Indo-African mantle plumes imaged by seismic tomography, Nat. Geosci., 14, 8, 612-619, DOI: 10.1038/s41561-021-00762-9

Madella, A. and Ehlers, T.A. (2021). Contribution of background seismicity to forearc uplift, Nat. Geosci., 14, 8, 620-625, DOI: 10.1038/s41561-021-00779-0

Tan, O. (2021). A homogeneous earthquake catalogue for Turkey, Nat. Hazards Earth Syst. Sci., 21, 7, 2059-2073, DOI: 10.5194/nhess-21-2059-2021

Li, J., Wang, J., Wang, X., Jiang, C., Wang, W. and Liu, J. (2021). Evaluation and comparison of the results of the NET-VISA seismic event association method based on Bayesian theory, Natural Hazards, 105, 2, 1521-1539, DOI: 10.1007/s11069-020-04364-3

Sawires, R., Santoyo, M.A., Peláez, J.A. and Henares, J. (2021). Western Mexico seismic source model for the seismic hazard assessment of the Jalisco-Colima-Michoacán region, Natural Hazards, 105, 3, 2819-2867, DOI: 10.1007/s11069-020-04426-6

Mishra, M., Abhishek, Yadav, R.B.S. and Sandhu, M. (2021). Probabilistic assessment of earthquake hazard in the Andaman-Nicobar-Sumatra region, Natural Hazards, 105, 313-338, DOI: 10.1007/s11069-020-04311-2

Surve, G., Kanaujia, J. and Sharma, N. (2021). Probabilistic seismic hazard assessment studies for Mumbai region, Natural Hazards, 107, 1, 575-600, DOI: 10.1007/s11069-021-04596-x

Salazar, W. (2021). Interoccurrence times and seismic hazard for upper-crustal volcanic chain earthquakes in El Salvador: are they Poissonian distributed?, Natural Hazards, 107, 2, 1443-1465, DOI: 10.1007/s11069-021-04640-w

Mandal, P., Srinagesh, D., Suresh, G., Naresh, B., Naidu, M., Singh, D., Swathi, K., Devi, A., Vittal, S., Vengala, P., Raghavan, R., Shekar, M. and Saha, S. (2021). Characterization of earthquake hazard at the Palghar and Pulichintala swarm activity regions (India) through three-dimensional modelling of b-value and fractal (correlation) dimensions, Natural Hazards, 108, 1, 1183-1196, DOI: 10.1007/s11069-021-04726-5

Pasari, S., Simanjuntak, A.V.H., Mehta, A., Neha and Sharma, Y. (2021). A synoptic view of the natural time distribution and contemporary earthquake hazards in

Sumatra, Indonesia, Natural Hazards, 108, 1, 309-321, DOI: 10.1007/s11069-021-04682-0

Zheng, G. and Geng, J. (2021). Tectonics-based shallow earthquake forecast of Taiwan Island, Natural Hazards, 109, 1, 133-144, DOI: 10.1007/s11069-021-04829-z

Kolathayar, S. (2021). Recent seismicity in Delhi and population exposure to seismic hazard, Natural Hazards, 109, 3, 2621-2648, DOI: 10.1007/s11069-021-04936-x

Dollet, C. and Guéguen, P. (2021). Global occurrence models for human and economic losses due to earthquakes (1967-2018) considering exposed GDP and population, Natural Hazards, 110, 1, 349-372, DOI: 10.1007/s11069-021-04950-z

Chubarov, L.B., Kikhtenko, V.A., Lander, A.V., Gusev, O.I., Beisel, S.A. and Pinegina, T.K. (2021). Technique of local probabilistic tsunami zonation for near-field seismic sources applied to the Bechevinskaya Cove (the Kamchatka Peninsula), Natural Hazards, 110, 1, 373-406, DOI: 10.1007/s11069-021-04951-y

Hwang, G.C., Hwang, H., Bang, Y., Choi, J., Park, Y., Jeon, T.Y., Chae, B., Jung, H. and Lee, Y. (2021). A role for subducted albite in the water cycle and alkalinity of subduction fluids, Nature Communications, 12, 1, DOI: 10.1038/s41467-021-21419-6

Augustin, N., van der Zwan, F.M., Devey, C.W. and Brandsdóttir, B. (2021). 13 million years of seafloor spreading throughout the Red Sea Basin, Nature Communications, 12, 2427, DOI: 10.1038/s41467-021-22586-2

Braszus, B., Goes, S., Allen, R., Rietbrock, A., Collier, J., Harmon, N., Henstock, T., Hicks, S., Rychert, C.A., Maunder, B., van Hunen, J., Bie, L., Blundy, J., Cooper, G., Davy, R., Kendall, J.M., Macpherson, C., Wilkinson, J. and Wilson, M. (2021). Subduction history of the Caribbean from upper-mantle seismic imaging and plate reconstruction, Nature Communications, 12, 4211, DOI: 10.1038/s41467-021-24413-0

Gahlaut, P., Patel, R.C., Ayyamperumal, R., Sati, M. and Nainwal, D.C. (2021). Assessment of Recent Tectonic Activity along the Yamuna Basin, Garhwal Region, NW-Himalaya, India: Based on Morphotectonic Analysis, Open Journal of Geology, 11, 12, 734-755, DOI: 10.4236/ojg.2021.1112036

Premthong, S., Won-in, K. and Pailoplee, S. (2021). Investigation of the international earthquake catalogues in the mainland southeast Asia, Phranakhon Rajabhat Research Journal, ahead of print

Dasgupta, S., Mukhopadhyay, B., Mukhopadhyay, M. and Pande, P. (2021). Geo- and seismo- tectonics of Eastern Himalaya: Exploring earthquake source zones from foredeep to Tibetan hinterland, Phys. Chem. Earth., 123, 103013, DOI: 10.1016/j.pce.2021.103013

Pavankumar, G. and Manglik, A. (2021). Complex tectonic setting and deep crustal seismicity of the Sikkim Himalaya: An electrical resistivity perspective, Phys. Chem. Earth., 124, 103077, DOI: 10.1016/j.pce.2021.103077

Andinisari, R., Konstantinou, K.I. and Ranjan, P. (2021). Seismicity along the Santorini-Amorgos zone and its relationship with active tectonics and fluid distribution, Phys. Earth planet. Interiors, 312, 106660, DOI: 10.1016/j.pepi.2021.106660

Frost, D.A. and Romanowicz, B. (2021). Effects of upper mantle structure beneath Alaska on core-sensitive seismic wave absolute and differential measurements: Implications for estimates of inner core anisotropy, Phys. Earth planet. Interiors, 315, 106713, DOI: 10.1016/j.pepi.2021.106713

Dey, C., Baruah, S., Rawat, G., Chetia, T., Baruah, S. and Sharma, S. (2021). Appraisal of contemporaneous application of polarization ratio and fractal analysis for studying possible seismo-electromagnetic emissions during an intense phase of seismicity in and around Assam Valley and the Eastern Himalayas, India, Phys. Earth planet. Interiors, 318, 106759, DOI: 10.1016/j.pepi.2021.106759

Zhao, D. and Hua, Y. (2021). Anisotropic tomography of the Cascadia subduction zone, Phys. Earth planet. Interiors, 318, 106767, DOI: 10.1016/j.pepi.2021.106767

Matcharashvili, T., Czechowski, Z., Chelidze, T. and Zhukova, N. (2021). Changes in the dynamics of seismic process observed in the fixed time windows; case study for southern California 1980-2020, Phys. Earth planet. Interiors, 319, 106783, DOI: 10.1016/j.pepi.2021.106783

Illa, B., Kumar, P., Reshma, K., Srinu, U. and Srinagesh, D. (2021). Sn wave tomography of the uppermost mantle beneath the Indian shield and its adjacent regions, Phys. Earth planet. Interiors, 319, 106785, DOI: 10.1016/j.pepi.2021.106785

Ogata, Y. (2021). Visualizing heterogeneities of earthquake hypocenter catalogs: modeling, analysis, and compensation, Prog. Earth Planet. Sci., 8:8, DOI: 10.1186/s40645-020-00401-8

Ahadov, B. and Jin, S. (2021). Slip Rates and Seismic Potential Along Main Faults in the Eastern Mediterranean and Caucasus from dense GPS Observations and Seismic Data, Pure appl. Geophys., 178, 1, 39-54, DOI: 10.1007/s00024-020-02643-5

Pilz, M., Isken, M.P., Fleming, K., Orunbaev, S. and Moldobekov, B. (2021). Long- and Short-Term Monitoring of a Dam in Response to Seasonal Changes and Ground Motion Loading: The Test Case of the Kurpsai Dam, Western Kyrgyz Republic, Pure appl. Geophys., 178, 10, 4001-4020, DOI: 10.1007/s00024-021-02861-5

Begnaud, M.L., Anderson, D.N., Myers, S.C., Young, B., Hipp, J.R. and Phillips, W.S. (2021). Updates to the Regional Seismic Travel Time (RSTT) Model: 2. Path-dependent Travel-time Uncertainty, Pure appl. Geophys., 178, 2, 313-339, DOI: 10.1007/s00024-021-02657-7

Rao, V.D. and Choudhury, D. (2021). Deterministic Seismic Hazard Analysis for the Northwestern Part of Haryana State, India, Considering Various Seismicity Levels, Pure appl. Geophys., 178, 2, 449-464, DOI: 10.1007/s00024-021-02669-3

Rahman, T. and Chhangte, R.L. (2021). A New Ground Motion Model (GMM) for Northeast India (NEI) and Its Adjacent Countries for Interface Earthquakes Considering Both Strong Motion Records and Simulated Data, Pure appl. Geophys., 178, 3, 1021-1045, DOI: 10.1007/s00024-021-02677-3

Gutierrez Peña, Q.J., Nava Pichardo, F.A., Glowacka, E., Castro Escamilla, R.R. and Márquez Ramírez, V.H. (2021). Assessing Markovian Models for Seismic Hazard and Forecasting, Pure appl. Geophys., 178, 3, 847-863, DOI: 10.1007/s00024-021-02686-2

Pasari, S., Simanjuntak, A.V.H., Mehta, A., Neha and Sharma, Y. (2021). The Current State of Earthquake Potential on Java Island, Indonesia, Pure appl. Geophys., 178, 8, 2789-2806, DOI: 10.1007/s00024-021-02781-4

Akilan, A., Padhy, S., Dimri, V.P., Schuh, H. and Azeez, K.K. (2021). Co-seismic and Post-seismic Changes in ZTD and TEC of the 2015 Nepal Earthquake, Pure appl. Geophys., 178, 9, 3339-3354, DOI: 10.1007/s00024-021-02830-y

Sakhaei, S.R., Mahood, M., Heidari, R. and Arian, M. (2021). Determination of Source, Site, and Path Effects of Mw = 7.3, 2017 Sarpol-e Zahab Using a Non-Parametric Generalized Inversion Technique, Pure appl. Geophys., 179, 1, 69-81, DOI: 10.1007/s00024-021-02881-1

Pisarenko, V.F. and Pisarenko, D.V. (2021). A Modified k-Nearest-Neighbors Method and Its Application to Estimation of Seismic Intensity, Pure appl. Geophys., ahead of print, DOI: 10.1007/s00024-021-02717-y

Kannaujiya, S., Gautam, P.K., Champati Ray, P.K., Chauhan, P., Singha Roy, P.N., Pal, S.K. and Taloor, A.K. (2021). Contribution of seasonal hydrological loading in the variation of seismicity and geodetic deformation in Garhwal region of Northwest Himalaya, Quat. Int., 575-576, 62-71, DOI: 10.1016/j.quaint.2020.04.049

Silpa, K. and Earnest, A. (2021). Revisiting the seismogenic characteristics of stable continental interiors: The case of three Indian events, Quat. Int., 585, 152-162, DOI: 10.1016/j.quaint.2020.12.035

Yadav, R., Gahalaut, V. and Bansal, A. (2021). Tectonic and non-tectonic crustal deformation in Kumaun Garhwal Himalaya, Quat. Int., 585, 171-182, DOI: 10.1016/j.quaint.2020.10.011

Zhu, C., Wang, C., Zhang, B., Qin, X. and Shan, X. (2021). Differential Interferometric Synthetic Aperture Radar data for more accurate earthquake catalogs, Remote Sens. Environ., 266, 112690, DOI: 10.1016/j.rse.2021.112690

Aboulela, H., Amin, A., Lashin, A. and Rayes, A.E. (2021). Contribution of geothermal resources to the future of renewable energy in Egypt: A case study, Gulf of Suez-Egypt, Renewable Energy, 167, 248-265, DOI: 10.1016/j.renene.2020.11.079

Pavlou, K., Kaviris, G., Kouskouna, V., Sakkas, G., Zymvragakis, A., Sakkas, V. and Drakatos, G. (2021). Minor seismic hazard changes in the broader area of Pournari artificial lake after the first filling (W. Greece), Results in Geophysical Sciences, 7, 100025, DOI: 10.1016/j.ringps.2021.100025

Zamora, N., Arroyo-Solórzano, M., Porras, H., Chacón, S., Rivera, F. and Murillo, A. (2021). Evaluación del potencial de tsunamis locales con base en análisis sismo-tectónico en el Caribe de Costa Rica, Revista Geológica de América Central, 65, DOI: 10.15517/rgac.v0i65.47002

Porras, H., Alvarado Induni, G.E., Arroyo-Solórzano, M., Durán, P. and Echandi, E. (2021). La depresión tectónica de Nicaragua en Costa Rica: estructura interna, estilo estructural, edad, extensión y actividad de la cuenca de San Carlos, Revista Geológica de América Central, 65, DOI: 10.15517/rgac.v0i65.46874

Klyuchevskii, A.V., Grebenshchikova, V.I., Kuz'min, M.I., Dem'yanovicha, V.I. and Klyuchevskaya, A.A. (2021). The Relationship between Powerful Geodynamic Impacts and an Increase in the Mercury Content of the Water of the Angara River Source (Baikal Rift Zone), Russ. Geol. Geophys., 62, 2, 239-254, DOI: 10.2113/rgg20194139

Ezzelarab, M., Hassoup, A., El-Ata, A.A., Lala, A.M., Hassan, D. and Adly, A. (2021). Integration of local soil effect into the assessment of seismic hazard at the Kharga Oasis, Western Desert, Egypt, Scientific African, 12, e00747, DOI: 10.1016/j.sciaf.2021.e00747

Pirli, M., Schweitzer, J., Paulsen, B., Konechnaya, Y. and Antonovskaya, G. (2021). Two Decades of Seismicity in Storfjorden, Svalbard Archipelago, from Regional Data, Scientific African, 92, 5, 2695-2704, DOI: 10.1785/0220200469

Riesner, M., Bollinger, L., Hubbard, J., Guérin, C., Lefèvre, M., Vallage, A., Basnet Shah, C., Kandel, T.P., Haines, S. and Sapkota, S.N. (2021). Localized extension in megathrust hanging wall following great earthquakes in western Nepal, Sci. Rep., 11, 1, DOI: 10.1038/s41598-021-00297-4

Obayashi, M., Yoshimitsu, J., Suetsugu, D., Shiobara, H., Sugioka, H., Ito, A., Isse, T., Ishihara, Y., Tanaka, S. and Tonegawa, T. (2021). Interrelation of the stagnant slab, Ontong Java Plateau, and intraplate volcanism as inferred

from seismic tomography, Sci. Rep., 11, 1, DOI: 10.1038/s41598-021-99833-5

Pappachen, J.P., Sathiyaseelan, R., Gautam, P.K. and Pal, S.K. (2021). Crustal velocity and interseismic strain-rate on possible zones for large earthquakes in the Garhwal–Kumaun Himalaya, Sci. Rep., 11, 1, DOI: 10.1038/s41598-021-00484-3

Derode, B., Madariaga, R. and Campos, J. (2021). Seismic rate variations prior to the 2010 Maule, Chile MW 8.8 giant megathrust earthquake, Sci. Rep., 11, 2705, DOI: 10.1038/s41598-021-82152-0

Pandey, A., Jayangondaperumal, R., Hetényi, G., Priyanka, R.S., Singh, I., Srivastava, P. and Srivastava, H.B. (2021). Establishing primary surface rupture evidence and magnitude of the 1697 CE Sadiya earthquake at the Eastern Himalayan Frontal thrust, India, Sci. Rep., 11, 879, DOI: https://doi.org/10.1038/s41598-020-79571-w 10.1038/s41598-020-79571-w

Kazaryan, K.S., Burmin, V.Y. and Sargsyan, R.S. (2021). Stress-Strain State of the Earth's Crust in the Central Caucasus, Seismic Instruments, 57, 2, 115-125, DOI: 10.3103/s0747923921020250

Petrova, N.V., Dyagilev, R.A. and Gabsatarova, I.P. (2021). Features of Seismic Impact Attenuation of the Russian Platform and Ural Earthquakes, Seismic Instruments, 57, 2, 132-149, DOI: 10.3103/s0747923921020304

Kazaryan, K.S., Burmin, V.Y. and Sargsyan, R.S. (2021). Redetermining the Parameters of Initial Seismological Data as an Important Link in Studying the Spatial Characteristics of Seismic Activity (a Case Study of the September 10, 2019, M = 4.7, Earthquake in Armenia), Seismic Instruments, 57, 3, 259-268, DOI: 10.3103/s0747923921030063

Lin, X., Hao, J., Wang, D., Chu, R., Zeng, X., Xie, J., Zhang, B. and Bai, Q. (2021). Coseismic Slip Distribution of the 24 January 2020 Mw~6.7 Doganyol Earthquake and in Relation to the Foreshock and Aftershock Activities, Seismol. Res. Lett., 92, 1, 127-139, DOI: 10.1785/0220200152

Wimpenny, S. and Watson, C.S. (2021). gWFM: A Global Catalog of Moderate-Magnitude Earthquakes Studied Using Teleseismic Body Waves, Seismol. Res. Lett., 92, 1, 212-226, DOI: 10.1785/0220200218

Agnew, D.C. (2021). Celebrity Earthquakes, Seismol. Res. Lett., 92, 1, 599-602, DOI: 10.1785/0220200329

Reddy, R.T., Dewangan, P., Bhaskaran, P.K. and Singha Roy, P.N. (2021). Possible Linkages between Microseisms in the Andaman-Nicobar Region and Swells in the South Indian Ocean, Seismol. Res. Lett., 92, 2A, 1052-1068, DOI: 10.1785/0220200193

Meletti, C., Camassi, R. and Castelli, V. (2021). A Reappraisal of the Seismicity of Sardinia, Italy, Seismol. Res. Lett., 92, 2A, 1148-1158, DOI: 10.1785/0220200255

Liberty, L.M., Lifton, Z.M. and Mikesell, T.D. (2021). The 31 March 2020 Mw~6.5 Stanley, Idaho, Earthquake: Seismotectonics and Preliminary Aftershock Analysis, Seismol. Res. Lett., 92, 2A, 663-678, DOI: 10.1785/0220200319

Schweitzer, J., Köhler, A. and Christensen, J.M. (2021). Development of the NORSAR Network over the Last 50 Yr, Seismol. Res. Lett., 92, 3, 1501-1511, DOI: 10.1785/0220200375

Heit, B., Cristiano, L., Haberland, C., Tilmann, F., Pesaresi, D., Jia, Y., Hausmann, H., Hemmleb, S., Haxter, M., Zieke, T., Jaeckl, K.-H., Schloemer, A. and Weber, M. (2021). The SWATH-D Seismological Network in the Eastern Alps, Seismol. Res. Lett., 92, 3, 1592-1609, DOI: 10.1785/0220200377

Mărmureanu, A., Ionescu, C., Grecu, B., Toma-Danila, D., Tiganescu, A., Neagoe, C., Toader, V., Craifaleanu, I.-G., Dragomir, C.S., Meiţă, V., Liashchuk, O.I., Dimitrova, L. and Ilieş, I. (2021). From National to Transnational Seismic Monitoring Products and Services in the Republic of Bulgaria, Republic of Moldova, Romania, and Ukraine, Seismol. Res. Lett., 92, 3, 1685-1703, DOI: 10.1785/0220200393

Galea, P., Agius, M.R., Bozionelos, G., D'Amico, S. and Farrugia, D. (2021). A First National Seismic Network for the Maltese Islands - The Malta Seismic Network, Seismol. Res. Lett., 92, 3, 1817-1831, DOI: 10.1785/0220200387

Morozov, A.N., Vaganova, N.V., Antonovskaya, G.N., Asming, V.E., Gabsatarova, I.P., Dyagilev, R.A., Shakhova, E.V. and Evtyugina, Z.A. (2021). Low-Magnitude Earthquakes at the Eastern Ultraslow-Spreading Gakkel Ridge, Arctic Ocean, Seismol. Res. Lett., 92, 4, 2221-2233, DOI: 10.1785/0220200308

Orecchio, B., Scolaro, S., Batlló, J., Neri, G., Presti, D., Stich, D. and Totaro, C. (2021). New Results for the 1968 Belice, South Italy, Seismic Sequence: Solving the Long-Lasting Ambiguity on Causative Source, Seismol. Res. Lett., 92, 4, 2364-2381, DOI: 10.1785/0220200277

Zaccarelli, R., Bindi, D. and Strollo, A. (2021). Anomaly Detection in Seismic Data-Metadata Using Simple Machine-Learning Models, Seismol. Res. Lett., 92, 4, 2627-2639, DOI: 10.1785/0220200339

Plasencia Linares, M.P., Cravos, C., Laterza, R., Bernardi, P., Comelli, P., Grossi, M., Magrin, A., Pesaresi, D., Sandron, D., Santulin, M., Sugan, M., Vuan, A. and Parolai, S. (2021). The Antarctic Seismographic Argentinean Italian Network (ASAIN): Recording Earthquakes in the Scotia Sea Region, Seismol. Res. Lett., 92, 5, 2748-2757, DOI: 10.1785/0220200484

Lamontagne, M. and Bent, A.L. (2021). Earthquakes in the Eastern Canadian Arctic: Past Occurrences, Present Hazard, and Future Risk, Seismol. Res. Lett., 92, 5, 2824-2837, DOI: 10.1785/0220210014

Antonovskaya, G.N., Basakina, I.M., Vaganova, N.V., Kapustian, N.K., Konechnaya, Y.V. and Morozov, A.N. (2021). Spatiotemporal Relationship between Arctic Mid-Ocean Ridge System and Intraplate Seismicity of the European Arctic, Seismol. Res. Lett., 92, 5, 2876-2890, DOI: 10.1785/0220210024

Heidarzadeh, M., Ishibe, T., Harada, T., Natawidjaja, D.H., Pranantyo, I.R. and Widyantoro, B.T. (2021). High Potential for Splay Faulting in the Molucca Sea, Indonesia: November 2019 Mw~7.2 Earthquake and Tsunami, Seismol. Res. Lett., 92, 5, 2915-2926, DOI: 10.1785/0220200442

Fan, F., Ye, L., Kanamori, H. and Lay, T. (2021). Responding to Media Inquiries about Earthquake Triggering Interactions, Seismol. Res. Lett., 92, 5, 3035-3045, DOI: 10.1785/0220200452

Liu, G., Qiao, X., Yu, P., Zhou, Y., Zhao, B. and Xiong, W. (2021). Rupture Kinematics of the 11 January 2021 Mw~6.7 Hovsgol, Mongolia, Earthquake and Implications in the Western Baikal Rift Zone, Seismol. Res. Lett., 92, 6, 3318-3326, DOI: 10.1785/0220210061

Tavera, H., Delouis, B., Mercado, A. and Portugal, D. (2021). Loreto Intermediate Depth Earthquake of 26 May 2019 (Northeast Peru): Source Parameters by Inversion of Local to Regional Waveforms and Strong-Motion Observations, Seismol. Res. Lett., 92, 6, 3349-3359, DOI: 10.1785/0220200459

Parolai, S., Sandron, D. and Rebez, A. (2021). The 9 October 1963 Vajont Catastrophe from the Point of View of the WWSSN-LP Recordings of the TRI-117 Station, Trieste, Italy, Seismol. Res. Lett., 92, 6, 3428-3436, DOI: 10.1785/0220200467

Martin, S.S., Bossu, R., Steed, R., Landès, M., Srinagesh, D., Srinivas, D. and Hough, S.E. (2021). When Punjab Cried Wolf: How a Rumor Triggered an "Earthquake" in India, Seismol. Res. Lett., 92, 6, 3887-3898, DOI: 10.1785/0220210130

Zaliapin, I. and Ben-Zion, Y. (2021). Perspectives on Clustering and Declustering of Earthquakes, Seismol. Res. Lett., 93, 1, 386-401, DOI: 10.1785/0220210127

Fan, G., Wang, J., Qi, S., Lu, G., Yang, X. and Zhou, J. (2021). Spatiotemporal Evolution of Earthquakes in Longmenshan Fault and Adjacent Area, before and after the 2008 Wenchuan Earthquake, Shock and Vibration, 2021, 9400276, DOI: 10.1155/2021/9400276

Nazaruddin, D.A. and Duerrast, H. (2021). Intraplate earthquake occurrence and distribution in Peninsular Malaysia over the past 100~years, SN Applied Sciences, 3, 693, DOI: 10.1007/s42452-021-04686-2

Nejad, R.G., Abbaspour, R.A. and Mojarab, M. (2021). Associating earthquakes with faults using cluster analysis optimized by a fuzzy particle swarm optimization algorithm for Iranian provinces, Soil Dyn. Earthquake Eng., 140, 106433, DOI: 10.1016/j.soildyn.2020.106433

Scaria, A., Gupta, I.D. and Gupta, V.K. (2021). An improved probabilistic seismic hazard mapping of peninsular shield region of India, Soil Dyn. Earthquake Eng., 141, 106417, DOI: 10.1016/j.soildyn.2020.106417

Ademović, N., Demir, V., Cvijić-Amulić, S., Málek, J., Prachař, I. and Vackář, J. (2021). Compilation of the seismic hazard maps in Bosnia and Herzegovina, Soil Dyn. Earthquake Eng., 141, 106500, DOI: 10.1016/j.soildyn.2020.106500

Gupta, I.D., Lee, V.W. and Trifunac, M.D. (2021). Seismic microzoning of Guwahati metropolitan area, Assam, India, Soil Dyn. Earthquake Eng., 142, 106562, DOI: 10.1016/j.soildyn.2020.106562

Gupta, A., Gupta, I.D. and Gupta, V.K. (2021). Probabilistic seismic hazard mapping of National Capital Region of India using a modified gridded seismicity model, Soil Dyn. Earthquake Eng., 144, 106632, DOI: 10.1016/j.soildyn.2021.106632

Elhadidy, M., Abdalzaher, M. and Gaber, H. (2021). Up-to-date PSHA along the Gulf of Aqaba-Dead Sea transform fault, Soil Dyn. Earthquake Eng., 148, 106835, DOI: 10.1016/j.soildyn.2021.106835

Williams, J.N., Mdala, H., Fagereng, Å., Wedmore, L.N.J., Biggs, J., Dulanya, Z., Chindandali, P. and Mphepo, F. (2021). A systems-based approach to parameterise seismic hazard in regions with little historical or instrumental seismicity: active fault and seismogenic source databases for southern Malawi, Solid Earth, 12, 1, 187-217, DOI: 10.5194/se-12-187-2021

Thorwart, M., Dannowski, A., Grevemeyer, I., Lange, D., Kopp, H., Petersen, F., Crawford, W.C. and Paul, A. (2021). Basin inversion: reactivated rift structures in the central Ligurian Sea revealed using ocean bottom seismometers, Solid Earth, 12, 11, 2553-2571, DOI: 10.5194/se-12-2553-2021

Petersen, G.M., Cesca, S., Heimann, S., Niemz, P., Dahm, T., Kühn, D., Kummerow, J. and Plenefisch, T. (2021). Regional centroid moment tensor~inversion of small to moderate earthquakes in the Alps using the dense AlpArray seismic network: challenges and seismotectonic insights, Solid Earth, 12, 6, 1233-1257, DOI: 10.5194/se-12-1233-2021

Barbero, I., Torrecillas, C., Páez, R., Prates, G. and Berrocoso, M. (2021). Recent Macaronesian kinematics from GNSS ground displacement analysis, Studia geophys. geod., 65, 1, 15-35, DOI: 10.1007/s11200-020-1122-x

Kijko, A., Vermeulen, P.J. and Smit, A. (2021). Estimation Techniques for Seismic Recurrence Parameters for Incomplete Catalogues, Survs Geophys., ahead of print, DOI: 10.1007/s10712-021-09672-2

Msabi, M.M. and Ferdinand, R.W. (2021). Probabilistic seismic hazard analysis for Northern Tanzania Divergence Region and the adjoining areas, Tanzania Journal of Science, 47, 2, 862-876, DOI: 10.4314/tjs.v47i2.40

Figueroa, S., Weiss, J.R., Hongn, F., Pingel, H., Escalante, L., Elías, L., Aranda-Viana, R.G. and Strecker, M.R. (2021). Late Pleistocene to Recent Deformation in the Thick-Skinned Fold-and-Thrust Belt of Northwestern Argentina (Central Calchaquí Valley, 26°S), Tectonics, 40, 1, e2020TC006394, DOI: 10.1029/2020TC006394

Fan, J. and Zhao, D. (2021). P-wave Tomography and Azimuthal Anisotropy of the Manila-Taiwan-Southern Ryukyu Region, Tectonics, 40, 2, e2020TC006262, DOI: 10.1029/2020tc006262

Stevens, V.L., Sloan, R.A., Chindandali, P.R., Wedmore, L.N.J., Salomon, G.W. and Muir, R.A. (2021). The Entire Crust can be Seismogenic: Evidence from Southern Malawi, Tectonics, 40, 6, e2020TC006654, DOI: 10.1029/2020tc006654

Higgins, M., La Femina, P.C., Weber, J.C., Geirsson, H., Ryan, G.A. and Wauthier, C. (2021). Strain Partitioning and Interseismic Fault Behavior Along the Caribbean-South American Transform Plate Boundary, Tectonics, 40, 8, DOI: 10.1029/2021tc006740

Sahara, D.P., Nugraha, A.D., Muhari, A., Rusdin, A.A., Rosalia, S., Priyono, A., Zulfakriza, Z., Widiyantoro, S., Puspito, N.T., Rietbrock, A., Lesmana, A., Kusumawati, D., Ardianto, A., Baskara, A.W., Halauwet, Y., Shiddiqi, H.A., Rafie, M.T., Pradisti, R., Mozef, P.W., Tuakia, M.Z. and Elly, E. (2021). Source mechanism and triggered large aftershocks of the Mw 6.5 Ambon, Indonesia earthquake, Tectonophysics, 799, 228709, DOI: 10.1016/j.tecto.2020.228709

Yuzariyadi, M. and Heki, K. (2021). Enhancement of interplate coupling in adjacent segments after recent megathrust earthquakes, Tectonophysics, 801, 228719, DOI: 10.1016/j.tecto.2021.228719

Cesca, S., Valenzuela Malebrán, C., López-Comino, J.Á., Davis, T., Tassara, C., Oncken, O. and Dahm, T. (2021). The 2014 Juan Fernández microplate earthquake doublet: Evidence for large thrust faulting driven by microplate rotation, Tectonophysics, 801, 228720, DOI: 10.1016/j.tecto.2021.228720

Arnaiz-Rodríguez, M.S., Zhao, Y., Sánchez-Gamboa, A.K. and Audemard, F. (2021). Crustal and upper-mantle structure of the Eastern Caribbean and Northern Venezuela from passive Rayleigh wave tomography, Tectonophysics, 804, 228711, DOI: 10.1016/j.tecto.2020.228711

Taymaz, T., Ganas, A., Yolsal-Çevikbilen, S., Vera, F., Eken, T., Erman, C., Keleş, D., Kapetanidis, V., Valkaniotis, S., Karasante, I., Tsironi, V., Gaebler, P., Melgar, D. and Öcalan, T. (2021). Source Mechanism and Rupture Process of the 24 January 2020 Mw 6.7 Doganyol-Sivrice Earthquake obtained from Seismological Waveform Analysis and Space Geodetic Observations on the East Anatolian Fault Zone (Turkey), Tectonophysics, 804, 228745, DOI: 10.1016/j.tecto.2021.228745

Esat, K., Seyitoğlu, G., Aktuğ, B., Kaypak, B. and Ecevitoğlu, B. (2021). The Northwest Central Anatolian Contractional Area: A neotectonic deformation zone bounded by major strike-slip fault zones in the Anatolian Plate, Tectonophysics, 805, 228776, DOI: 10.1016/j.tecto.2021.228776

Ezgi Güvercin, S., Özgün Konca, A., Değer Özbakır, A., Ergintav, S. and Karabulut, H. (2021). New focal mechanisms reveal fragmentation and active subduction of the Antalya slab in the Eastern Mediterranean, Tectonophysics, 805, 228792, DOI: 10.1016/j.tecto.2021.228792

Hajra, S., Hazarika, D., Kumar, N., Pal, S.K. and Roy, P.N.S. (2021). Seismotectonics and stress perspective of the Kumaon Himalaya: A geophysical evidence of a Lesser Himalayan duplex, Tectonophysics, 806, 228801, DOI: 10.1016/j.tecto.2021.228801

Niassarifard, M., Shabanian, E., Azad, S.S. and Madanipour, S. (2021). New tectonic configuration in NW Iran: Intracontinental dextral shear between NW Iran and SE Anatolia, Tectonophysics, 811, 228886, DOI: 10.1016/j.tecto.2021.228886

Sheikholeslami, M.R., Mobayen, P., Javadi, H.R. and Ghassemi, M.R. (2021). Stress field and tectonic regime of Central Iran from inversion of the earthquake focal mechanisms, Tectonophysics, 813, 228931, DOI: 10.1016/j.tecto.2021.228931

Illa, B., Reshma, K.S., Kumar, P., Srinagesh, D., Haldar, C., Kumar, S. and Mandal, P. (2021). Pn tomography and anisotropic study of the Indian shield and the adjacent regions, Tectonophysics, 813, 228932, DOI: 10.1016/j.tecto.2021.228932

Arroyo-Solórzano, M. and Linkimer, L. (2021). Spatial variability of the b-value and seismic potential in Costa Rica, Tectonophysics, 814, 228951, DOI: 10.1016/j.tecto.2021.228951

Wu, W.-N., Lo, C.-L., Doo, W.-B., Lin, J.-Y. and Hsu, S.-K. (2021). Seismogenic structure along the deformation front off SW Taiwan revealed by the aftershocks of the 2017 Tainan near-shore earthquake with ocean bottom seismometers, Tectonophysics, 815, 228995, DOI: 10.1016/j.tecto.2021.228995

Sreejith, K.M., Jasir, M.C.M., Agrawal, R. and Rajawat, A.S. (2021). The 2019 September 24, Mw=6, Mirpur

earthquake, NW Himalaya: Geodetic evidence for shallow, near-horizontal d'ecollement rupture of the Main Himalayan Thrust, Tectonophysics, 816, 229013, DOI: 10.1016/j.tecto.2021.229013

Aflaki, M. and Mousavi, Z. (2021). Interaction between the far-field stress and crustal boundary faults in the kinematics of active deformation around the Lut Block, Eastern Iran, Tectonophysics, 817, 229053, DOI: 10.1016/j.tecto.2021.229053

Bai, Y., He, Y., Yuan, X., Tilmann, F., Ai, Y., Jiang, M., Hou, G., Mon, C.T., Thant, M. and Sein, K. (2021). Seismic structure across central Myanmar from joint inversion of receiver functions and Rayleigh wave dispersion, Tectonophysics, 818, 229068, DOI: 10.1016/j.tecto.2021.229068

de Melo, G.W.S., Mitchell, N.C., Zahradnik, J., Dias, F. and F. do Nascimento, A. (2021). Oceanic seismotectonics from regional earthquake recordings: The 4–5°N mid-Atlantic ridge, Tectonophysics, 819, 229063, DOI: 10.1016/j.tecto.2021.229063

El-Sharkawy, A., Meier, T., Hübscher, C., Lebedev, S., Dannowski, A., Kopp, H., Behrmann, J., McGrandle, A. and Hamada, M. (2021). Lithospheric structure of the eastern Mediterranean Sea: Inferences from surface wave tomography and stochastic inversions constrained by wide-angle refraction measurements, Tectonophysics, 821, 229159, DOI: 10.1016/j.tecto.2021.229159

Abdel-Fattah, M.I., Shendi, E.-A.H., Kaiser, M.F. and Abuzied, S.M. (2021). Unveiling geothermal potential sites along Gulf of Suez (Egypt) using an integrated geoscience approach, Terra Nova, 33, 3, 306-319, DOI: 10.1111/ter.12516

Zhang, J., Zhang, F., Yang, H., Lin, J. and Sun, Z. (2021). The effects of plateau subduction on plate bending, stress and intraplate seismicity, Terra Nova, 34, 2, 113-122, DOI: 10.1111/ter.12570

de la Barra, E. and Vega-Jorquera, P. (2021). On q-pareto distribution: some properties and application to earthquakes, The European Physical Journal B, 94, 1, DOI: 10.1140/epjb/s10051-021-00045-7

Lecoulant, J., Oliveira, T.C.A. and Lin, Y.-T. (2021). Three-dimensional modeling of T-wave generation and propagation from a South Mid-Atlantic Ridge earthquake, The Journal of the Acoustical Society of America, 150, 5, 3807-3824, DOI: 10.1121/10.0007072

Khan, M.Y., Turab, S.A., Ali, L., Shah, M.T., Talha Qadri, S.M., Latif, K., Kanli, A.I. and Akhter, M.G. (2021). The dynamic response of coseismic liquefaction-induced ruptures associated with the 2019 Mw 5.8 Mirpur, Pakistan, earthquake using HVSR measurements, The Leading Edge, 40, 8, 590-600, DOI: 10.1190/tle40080590.1

Subedi, S. and Hetényi, G. (2021). Precise Locating of the Great 1897 Shillong Plateau Earthquake Using Teleseismic and Regional Seismic Phase Data, The Seismic Record, 1, 3, 135-144, DOI: 10.1785/0320210031

Sargsyan, R.S., Ghazaryan, K.S. and Burmin, V.Y. (2021). Seismotectonics of Armenia: main problems, Vestnik of Saint Petersburg University. Earth Sciences, 66, 3, DOI: 10.21638/spbu07.2021.310

Massin, F., Clouard, V., Vorobieva, I., Beauducel, F., Saurel, J.-M., Satriano, C., Bouin, M.-P. and Bertil, D. (2021). Automatic picking and probabilistic location for earthquake assessment in the Lesser Antilles subduction zone (1972-2012), Comptes Rendus Géoscience, 353, S1, 1-23, DOI: 10.5802/crgeos.81

Jiménez Morales, V. (2021). Estudio sismológico de la actividad y la estructura del Volcán Isla Decepción (Antártida), mediante el análisis de datos continuos registrados en una estación sísmica pernente (2008-2015), PhD Thesis Univ. Granada, Spain

da Silva Almeida, G.P. (2021). Hypocenter determination of local earthquakes using data from local stations in and around Timor Leste, Synopsis of IISEE-GRIPS Master's Thesis

Onur, T., Gok, R., Mackey, K., Abras, K., Berezina, A., Mikhailova, N., Bekturganova, B., Murodkulov, S., Bondár, I. and Herrera, C. (2021). Central Asia Seismic Hazard Assessment (Casha) "Complete" Catalogue of Earthquakes, LLNL-TR-828313, URL: https://www.osti.gov/servlets/purl/1827508

Maksymchyk, V., Pyrizhok, N., Nakalov, Y., Yarema, I. and Yanush, L. (2021). Seismicity of the Maramures basin, Geoinformatics, Proc. EAGE, DOI: 10.3997/2214-4609.20215521073

Mehta, P. and Thaker, T.P. (2021). Probabilistic Seismic Hazard Analysis of Vadodara Region, In: Latha Gali M., Raghuveer Rao P. (eds) Geohazards. Lecture Notes in Civil Engineering, vol 86. Springer, Singapore, 353-366, DOI: 10.1007/978-981-15-6233-4_25

Saha, A., Saha, K. and Dey, A.K. (2021). Seismic Site Classification and Site Period Determination of NIT Silchar Using MASW, In: Latha Gali M., Raghuveer Rao P. (eds) Geohazards. Lecture Notes in Civil Engineering, vol 86. Springer, Singapore, 507-522, DOI: 10.1007/978-981-15-6233-4_36

Dinh, T., Xuan, B., Nam, H., Anh, T., Kha, V. and Dinh, T. (2021). Seismic Hazard Assessment for South-Central Region, Vietnam, In: Tien Bui D., Tran H.T., Bui XN. (eds) Proceedings of the International Conference on Innovations for Sustainable and Responsible Mining. Lecture Notes in Civil Engineering, Springer, Cham, 167-191, DOI: 10.1007/978-3-030-60269-7_9

Harith, N.S.H., Tongkul, F., Adiyanto, M.I. and Rizalman, A.N. (2021). Effect of Long-Distance Earthquake from Philippines and Sulawesi to Sabah Region, IOP Conference Series: Earth and Environmental Science, 682, 1,012012, DOI: 10.1088/1755-1315/682/1/012012

Basid, A., Mahardika, I.K., Subchan, W. and Astutik, S. (2021). Mapping risk levels of earthquake damage as disaster mitigation efforts: Case studies in West Java, Central Sulawesi and Lombok, The 4th International Conference on Mathematics and Science Education (Icomse) 2020: Innovative Research in Science and Mathematics Education in The Disruptive Era, DOI: 10.1063/5.0037540

Wei, R.Q. (2021). Locating earthquake epicenter without a seismic velocity model, arXiv, URL: https://arxiv.org/abs/2108.08928

Wei, R.Q. (2021). Application of minimum entropy deconvolution to detect pP phase in a seismogram, arXiv, URL: https://arxiv.org/abs/2108.08927

Srivastava, N., Sayed, O.E., Chakraborty, M., Köhler, J., Steinheimer, J., Faber, J., Kies, A., Thingbaijam, K.K., Zhou, K., Ruempker, G. and Stoecker, H. (2021). Sunda-arc seismicity: continuing increase of high-magnitude earthquakes since 2004, arXiv, URL: https://arxiv.org/abs/2108.06557

Tadapansawut, T., Yuji, Y., Okuwaki, R., Yamashita, S. and Shimizu, K. (2021). Complex rupture process of the 2014 Thailand Mw 6.2 earthquake on the conjugate fault system of the Phayao fault zone, EarthArXiv, DOI: 10.31223/x56p7t

Feng, L. (2021). Mapping Crustal and Uppermost Mantle Deformation in the Westernmost Mediterranean by Radial Anisotropy, EarthArXiv, DOI: 10.31223/x5tc8p

Salazar, W. (2021). Cross-validated Probabilistic Seismic Hazard, Research Square, DOI: 10.21203/rs.3.rs-310370/v1

Cai, J., Dai, X., zhitao, G. and Shi, Y. (2021). Automatic Phase Identification of Earthquake Based on the UBDN Deep Network, DOI: 10.21203/rs.3.rs-417923/v1

Waseem, M. and Erdik, M. (2021). Updated Probabilistic Seismic Hazard Assessment of Pakistan, DOI: 10.21203/rs.3.rs-1146457/v1

Reid, J., Liu, J. and Ananthabhotla, B. (2021). QuakeCast, an Earthquake Forecasting System Using Ionospheric Anomalies and Machine Learning, DOI: 10.1002/essoar.10506273.1

Murotani, S., Satake, K., Ishibe, T. and Harada, T. (2021). Reexamination of Tsunami Source Models For the 20th Century Earthquakes Off Hokkaido and Tohoku Along the Eastern Margin of the Sea of Japan, DOI: 10.21203/rs.3.rs-940165/v1

Huang, B.-S. and Chang, C.-P. (2021). Complicated Source Rupture Process and Induced Coseismic Surface Deformation of the Wenchuan Mw 7.9 Earthquake and Their Tectonic Implications, In: Lo CH., Xu X., Chang WY., Ando M. (eds) Earthquake Geology and Tectonophysics around Eastern Tibet and Taiwan. Atmosphere, Earth, Ocean & Space. Springer, Singapore, 1-23, DOI: 10.1007/978-981-15-6210-5_1

Kumar, N., Hazarika, D. and Sain, K. (2021). Earthquakes: Basics of seismology and computational techniques, In: P. Samui, B. Dixon, D. Tien Bui (eds.), Basics of Computational Geophysics, Elsevier, 47-80, DOI: 10.1016/b978-0-12-820513-6.00023-0

Kumar, P. and Sandeep (2021). A review on geophysical parameters comparison in Garhwal and Kumaun Himalaya region, India, In: P. Samui, B. Dixon, D. Tien Bui (eds.), Basics of Computational Geophysics, Elsevier, 95-103, DOI: 10.1016/b978-0-12-820513-6.00017-5

ElGabry, M. and Hassan, H.M. (2021). Updated Seismic Input for Next Generation of the Egyptian Building Code, In: Shehata H., El-Badawy S. (eds) Sustainable Issues in Infrastructure Engineering. Sustainable Civil Infrastructures. Springer, Cham, 55-79, DOI: 10.1007/978-3-030-62586-3_5

Rodkin, M.V. and Zharikov, A.V. (2021). Permeability of the Continental Crust - Possible High Values from Laboratory Measurements and Seismological Data, In: Svalova V. (eds) Heat-Mass Transfer and Geodynamics of the Lithosphere. Innovation and Discovery in Russian Science and Engineering. Springer, Cham, 481-498, DOI: 10.1007/978-3-030-63571-8_29

Kolathayar, S. and Sitharam, T.G. (2021). Seismic Hazard Assessment of Nuclear Power Plant Site in Jaitapur: Deterministic and Probabilistic Approaches, Sitharam T.G., Kolathayar S., Sharma M.L. (eds) Seismic Hazards and Risk. Lecture Notes in Civil Engineering, Springer, Singapore, 15-26, DOI: 10.1007/978-981-15-9976-7_2